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RECORD OF DECISION

FOR THE

BAXTER SPRINGS AND TREECE SUBSITES

OPERABLE UNITS #03/#04

CHEROKEE COUNTY SUPERFUND SITE

CHEROKEE COUNTY, KANSAS

Prepared by:

U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION VII

KANSAS CITY, KANSAS

AUGUST 1997

RECORD OF DECISION

DECLARATION

SITE NAME AND LOCATION

Baxter Springs and Treece Subsites - Operable Units #03/#04
Cherokee County Superfund Site
Cherokee County, Kansas

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the mining and milling wastes at the Baxter Springs and Treece subsites, which are part of the Cherokee County Superfund site in Cherokee County, Kansas. This decision was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Contingency Plan (NCP). This decision is based on the Administrative Record for this site. The Administrative Record file is located in the following information repositories:

Johnston Public Library
210 West 10th Street
Baxter Springs, Kansas

U.S. Environmental Protection Agency
Region VII Docket Room
726 Minnesota Avenue
Kansas City, Kansas

The state of Kansas concurs with the selected remedy. The local community also concurs with this remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), present a current threat to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The U.S. Environmental Protection Agency (EPA) believes the selected remedy appropriately addresses the principal current and potential risks to human health and the environment. The remedy addresses human health risks at both subsites and ecological risks at the Baxter Springs subsite. The selected remedy includes actions for the source materials (mining/milling wastes), groundwater, surface water, and soils. This single ROD addresses two discrete subsites of the Cherokee County site. The major components of the selected remedy, which are specific to only the Baxter Springs subsite, include the following:

- Excavation, relocation, regrading, capping, and revegetation of mine/mill waste piles, tailings impoundments, and tailings outwash deposits;
- Stream re-channelization and construction of stream diversion/control structures; and
- Prevention of mine water discharges.

The major remedy components for both the Baxter Springs and Treece subsites include the following:

- Investigation and potential remediation of residential yards impacted by mining/milling wastes;
- Closure/abandonment of poorly constructed existing deep water wells and borings to protect the deep aquifer;
- Institutional controls for future development; and
- Operation and maintenance of all remedy aspects which include, but are not limited to, the following: capped areas; stream diversion/control structures; institutional controls; and long-term monitoring.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state laws that are legally applicable or relevant and appropriate requirements (ARARs) for the remedial action, and is cost effective. However, chemical-specific ARARs under the Clean Water Act regulating surface water quality and the Safe Drinking Water Act regulating groundwater drinking water will not be met by the selected remedy. EPA has determined that it is technically impractical to meet these standards at both subsites.

This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. However, because treatment of the principal threats was not found to be practicable, this remedy does not satisfy the statutory preference for treatment as a principal element.

This remedy will result in hazardous substances remaining on the site above health based levels. Therefore, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

for William Rice

Dennis Grams, P.E.
Regional Administrator
U.S. EPA, Region VII

8/28/97

Date

RECORD OF DECISION

DECISION SUMMARY

BAXTER SPRINGS AND TREECE SUBSITES

OPERABLE UNITS #03/#04

CHEROKEE COUNTY SUPERFUND SITE

CHEROKEE COUNTY, KANSAS

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U.S. ENVIRONMENTAL PROTECTION AGENCY

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KANSAS CITY, KANSAS

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DECISION SUMMARY

1.0 Site Description

The Cherokee County Superfund site is located in the extreme southeast portion of the state of Kansas and encompasses an area of approximately 115 square miles. This site is designated as a megasite due to its large size and subdivision into several subsites and operable units. A wide variety of response actions have been conducted to date. The Baxter Springs and Treece subsites (shown on Figure 1) consist of two of the six subsites which make up the Cherokee County, Kansas Superfund site and are part of the former Picher mining field which is centered near the town of Picher, Oklahoma. The Picher mining field extended northward from Oklahoma into southeastern Kansas and was one of the most productive lead and zinc mining areas in the United States. This area is part of the larger Tri-State Mining District which covers approximately 500 square miles in southeast Kansas, southwest Missouri, and northeast Oklahoma.

The surface area of the Baxter Springs subsite is approximately 17 square miles or 10,880 acres while the surface area of the Treece subsite is approximately 11 square miles or about 7,040 acres. The Baxter Springs and Treece subsites are underlain by mine workings with depths ranging from approximately 200 to 500 feet below the surface. It is estimated that 1,255 acres within these subsites are covered with surficial mining/milling waste piles, tailings impoundments, and stream outwash tailings deposits.

These two discrete subsites are being addressed by a single Record of Decision (ROD) due to their close proximity and similarity of wastes. However, as noted in the following paragraphs, the subsites are contained within different watersheds or drainage basins and thus contribute contaminants to different stream systems and receptors. This is an important point to note as the selected remedy specifies certain differing actions for the two subsites as well as some common remedy components for both subsites.

The Baxter Springs subsite is drained by Willow Creek, Spring Branch, and other small unnamed drainages. These drainages flow predominantly to the east-southeast and discharge to the Spring River. The Spring River eventually discharges into the Neosho River at the Grand Lake O' the Cherokees in Ottawa County, Oklahoma (see Figure 1). The state of Kansas has designated the lower portion of Spring Branch as a critical habitat for nine threatened or endangered species. These species are listed in the Remedial Investigation (RI) report and the Ecological Risk Assessment (ERA) report, which are available in the Administrative Record.

The Treece subsite is drained primarily by Tar Creek, which exits the Kansas portion of the Picher field near the town of Treece, Kansas and drains much of the Oklahoma portion of the Picher field. Tar Creek discharges into the Neosho River near the town of Miami, Oklahoma (see Figure 1). The Treece subsite has also been designated by the state of Kansas as a critical habitat for a threatened or endangered species as discussed in the ERA. The Treece subsite is contiguous with the Tar Creek Superfund site in Oklahoma.

The Baxter Springs and Treece subsites have been contaminated with hazardous substances as a result of the mining and milling of lead and zinc ores. Hazardous substances, primarily lead, zinc, and cadmium, are found in the surface water, sediments, soils, mine/mill wastes, and groundwater within these subsites.

2.0 Site History

Discoveries of mineral deposits in Kansas are reported as early as 1870, when zinc deposits were discovered near Galena. Discoveries of lead and zinc deposits from the Picher field date back to as early as 1901 in the vicinity of Lincolnville, Oklahoma.

The first commercial production of lead and zinc ore from the Picher field was in 1904. Mining operations continued in the Picher field through the 1950s, with the last large mining company closing down underground mining operations in 1958. Smaller mining operations continued in the Picher field area until 1970, when all mining essentially ceased. Since the late

1960s, the mill waste piles of the Picher field have been actively quarried for commercial uses such as construction, concrete aggregate, railroad ballast, highway and secondary road construction, and sandblasting.

The mining and processing activities conducted at these subsites, in addition to subsequent weathering, use, and transport, have resulted in contamination of surface water, sediment, soil, and groundwater with heavy metals. The U.S. Environmental Protection Agency (EPA) began environmental investigations in the Picher field in 1984. EPA placed the Cherokee County Superfund site on the National Priorities List (NPL) in 1983 pursuant to Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §9605. The site encompasses the towns of Galena, Baxter Springs, Treece, and Riverton, as well as the small rural areas of Badger, Lawton, and Waco.

EPA separated the Cherokee County megasite into subsites to initially focus and expedite the field investigations and subsequent remediation of contaminant sources in the most heavily impacted areas. The six subsites are designated as Galena, Baxter Springs, Treece, Badger, Lawton, and Waco (see Figure 1). These six subsites encompass the majority of the areas where physical disturbances are evident and thus represent the major areas of past mining activities. The Galena subsite was addressed initially due to the potential for exposure of the largest population. The Baxter Springs and Treece subsites were subsequently addressed followed by preliminary evaluation of the Badger, Lawton, and Waco subsites.

3.0 Highlights of Community Participation

EPA Region VII encouraged public review and comment on the preferred remedial alternative by providing the public with the proposed plan and supporting documents included in the Administrative Record file. In order to provide the community with an opportunity to submit written or oral comments, EPA established a public comment period from August 18, 1994, to September 16, 1994. This period was extended for an additional thirty days to October 16, 1994 due to public interest. A public meeting was held on August 25, 1994, at 7:00 p.m. at the Community Center in Baxter Springs, Kansas, to present the proposed plan, accept written and oral comments, and to answer questions concerning the preferred alternative. At this meeting, representatives from EPA and the Kansas Department of Health and Environment (KDHE) answered questions about the subsites and the remedial alternatives under consideration. Responses to the questions and comments received during the public comment period are included in the Responsiveness Summary, which is provided as Attachment #1 to this Record of Decision (ROD). The decision for these two subsites is based on the information contained in the Administrative Record file which is located at the earlier referenced repositories.

4.0 Scope and Role of Operable Units

The six previously described subsites of the Cherokee County site are grouped into the following operable units (OUs): OU-1, Galena Alternate Water Supply; OU-3, Baxter Springs; OU-4, Treece; OU-5, Galena Groundwater/Surface Water; OU-6, Badger, Lawton, and Waco; and OU-7, Galena Residential Soils. One former OU (OU-2, Spring River) no longer exists as the Spring River is encompassed by the other existing OUs. An "operable unit" is a term used by EPA to subdivide a site or subsite into parcels of work. It is simply a means for EPA to efficiently complete work at a large site in a step wise fashion. Operable units are typically named and numbered. The operable unit approach initially targeted impacted groundwater used as a drinking water source near Galena, Kansas (OU-1) and the subsequent remediation of impacts to the groundwater and surface water (OU-5). These actions were followed by addressing impacted residential soils in the community of Galena (OU-7). Activities at OU-1 and OU-7 also included early removal actions which were followed by remedial actions. Remedial actions at OU-1 and OU-5 are complete while OU-7 cleanup work is ongoing. The OU-6 effort will be the final action at the site due to the rural area (small potentially affected population) and small volume of wastes as compared to the other areas. This ROD addresses OU-3/OU-4, the Baxter Springs and Treece subsites.

The Galena subsite response actions are consistent with the selected remedy for the Baxter Springs and Treece subsites. Remedial actions at the Galena subsite were selected in two RODs issued in 1987 and 1989 and were performed by EPA. The 1987 ROD required installation of a public water supply for approximately

500 residences at the subsite while the 1989 ROD required remediation of impacts to groundwater and surface water in the following manner:

- Selective placement of surface mine wastes to reduce human exposure and migration of contaminants into the groundwater and surface streams;

- Surface water diversions to prevent stream capture by mine shafts and subsidences;

- Surface recontouring to reduce surface water infiltration and ponding; and

- Inspection of wells penetrating the Roubidoux aquifer, and plugging or lining of these wells as necessary to protect the deep aquifer.

EPA implemented the remedial actions for the public water supply and the groundwater/surface water cleanup using Superfund monies. The public water supply installation (OU-1) and the groundwater/surface water cleanup (OU-5) are complete and now in the operation and maintenance phase. EPA recovered partial funding for these actions in subsequent bankruptcy and cost recovery cases. These actions were completed first due to the large amount of wastes near populated areas and the impact resulting from consumption of metals laden groundwater.

EPA initiated investigations at the Baxter Springs and Treece subsites in 1990 by issuing an Administrative Order on Consent (AOC), Docket Number VII 90-F-0010, dated May 8, 1990, to a group of potentially responsible parties (PRPs). The PRPs include the following companies:

- AMAX, Inc.;
- ASARCO, Inc.;
- Eagle-Picher Industries, Inc.;
- Gold Fields American Corporation;
- NL Industries, Inc.;
- St. Joe Minerals Corporation (The Doe Run Co.); and
- Sun Company, Inc.

Under the terms of the AOC, the Respondents performed the RI, including the Human Health Risk Assessment (HHRA), ERA, and FS for the Baxter Springs and Treece subsites. EPA subsequently developed a technical memorandum, dated January 5, 1994, which recommended a remedial alternative and served as a basis for a feasibility study addendum (FS Addendum) prepared by the Respondents. Respondents submitted the FS Addendum in June 1994. The FS report, FS Addendum, and EPA's technical memorandum are included in the Administrative Record, along with the RI, HHRA and ERA reports.

The selected remedy for the Baxter Springs and Treece subsites is consistent with the Galena OU-7 ROD in regard to the cleanup of source materials and residential areas. EPA completed a ROD for the impacted residential areas of Galena (OU-7) in July 1996. This remedial action is currently underway (1997) and is planned for completion in 1998. The OU-7 ROD provided for the excavation and disposal of residential soils impacted by mining, milling, and smelting wastes.

5.0 Baxter Springs and Treece Subsite Characteristics

Past mining practices produced approximately 75 million cubic yards of mine and mill wastes within these subsites, of which approximately 4.3 million cubic yards remain today. The surficial mine wastes at the subsites also consist of development and waste rock that have little mineralization (non-milled material). Mill wastes consist of the fine (tailings impoundment derived) and coarse grained (commonly referred to as "chat") mill tailings that have elevated levels of metals. For purposes of this ROD, all wastes, including development rock, waste rock, chat, and fine grained flotation impoundment tailings are referred to as mine wastes. Since the surficial mine wastes were originally excavated from mineralized strata, they contain minerals characteristic of the mining district, chiefly, galena and sphalerite. The mine wastes contain heavy metals at concentrations above natural background soil levels. The metals which are the contaminants of concern include cadmium, lead, and zinc; however, the mine wastes also contain the following hazardous substances: arsenic; copper; mercury; and manganese.

The predominant focus is on lead, cadmium, and zinc because these constituents exceed acceptable risk management or regulatory concentration levels and create unacceptable risks to human or ecological receptors.

The RI report for the Baxter Springs and Treece subsites indicates that contaminants, principally heavy metals in the soils, surface mine wastes, shallow groundwater, sediments, and onsite surface water bodies represent the principal threats to human health and the environment. The main routes of exposure with respect to human health are through direct contact with and ingestion of the soil or surface mine wastes, and potential uptake of contaminants through locally grown produce, beef, and dairy products. Lesser potential routes of exposure include air and water media.

With respect to environmental impacts, the main concerns are direct uptake of contaminants from water by aquatic organisms and the potential for impacting critical habitat for state listed, threatened, or endangered species. The shallow groundwater, which is currently not being used as a source of drinking water, is contaminated with hazardous substances, including lead, cadmium, and zinc.

The development rock is from shaft excavation and is mostly the nonmineralized overbearing Pennsylvanian age shales and limestones. The waste rock is the oversized material from opening the lateral drifts or tunnels. The development and waste rock cover about 18 acres within these subsites (about 200,000 cubic yards) and are insignificant sources of the contaminants of concern compared to the mill wastes.

The mill wastes represent the main source of hazardous substances at these subsites. The coarse grained material known as "chat" represents the residual material from the jigging and tabling milling processes. Chat normally ranges from about 1/64 to 3/8 inch in diameter. The metals in the chat are primarily concentrated in the finer materials which generally make up 3 to 12 percent of the total volume. The average concentrations of lead and zinc in the chat piles range from 360 to 1,500 parts per million (ppm) and 6,000 to 13,000 ppm, respectively.

The flotation tailings represent the fine residual materials which remain from the froth flotation milling processes. These tailings are fine grained and are silt sized or smaller (finer than a 200-mesh screen). Similar to chat, the metals are more heavily concentrated in the finer grained material. The average lead concentration in flotation tailings is approximately five times higher than the concentration in typical chat and ranges from 380 to 5,900 ppm. Zinc concentrations in flotation tailings are also much higher than in chat and range from 3,800 to 64,000 ppm.

Most of the flotation tailings (90 percent) within these subsites occur within impoundments. However, there are some tailings impoundments where the dikes have been eroded or overtopped, and the tailings have washed into adjoining areas or streams. These outwash areas cover 27 acres in these subsites and are a major source of contamination. At least eight areas within these subsites have outwash tailings material in the streams which have been mixed with other stream sediments. Figure 2 depicts the various types of mine wastes at the Baxter Springs subsite that are addressed by the selected alternative.

Soils in the immediate vicinity of the surface mine wastes have elevated levels of metals. This is likely a result of several processes which include the following: transport of windblown dust from all types of mining wastes; erosion from the chat and tailings areas; transport of contaminants via surface water flows or groundwater seeps; and mechanical redistribution from chat quarrying operations. All of the previously described types of mining wastes, bedrock, and soils may be commingled in various combinations.

Two major aquifer systems, referred to as the shallow and deep aquifers, underlie these subsites. The shallow aquifer is comprised of Mississippian age limestones which host the lead-zinc mineral deposits that were mined at these subsites. Water from the shallow aquifer is not frequently used at these subsites for domestic or livestock supplies because it is low yielding and the quality is generally poor. Water from wells in the shallow aquifer is laden with calcium sulfate and regularly exceeds secondary safe drinking water standards for iron, manganese, and sulfate. Water quality data from wells located in the shallow aquifer in the non-mined area east of Baxter Springs indicate that the water is potable; thus it is highly probable that past mining activities have degraded the water quality of the upper most aquifer.

The deep aquifer occurs in lower Ordovician age sandy dolomite and provides the principal source of water for public, industrial, domestic, and livestock supplies at these subsites and surrounding areas. Water in the deep aquifer contains calcium bicarbonate or calcium magnesium bicarbonate and is adequate for most uses. East of the Spring River, the deep aquifer water generally has less than 500 milligrams per liter (mg/l) of dissolved solids with minor detectable concentrations of trace metals. West of the river, the dissolved solids concentrations increase up to 1,030 mg/l and concentrations of trace metals are similar as to the east. While the deep aquifer is predominantly clean and not impacted by mine wastes, the RI report concluded that it could potentially become impacted by faulty well seals or leaky casings in wells installed within the lower aquifer. The available data indicates that mine water has not migrated from the shallow aquifer to the deep aquifer through the intervening geologic strata. The intervening strata was thus determined to be an adequate confining unit or aquitard.

The RI report assesses the metals loading contributed to the Spring and Neosho Rivers by the streams and creeks in the Baxter Springs and Treece subsites. The combined zinc loading to the Spring River from Willow Creek and Spring Branch at the Baxter Springs subsite is approximately 24,000 pounds per year. The zinc load contributed to the Neosho River from the Tar Creek drainage basin within the Treece subsite is estimated at 220,000 pounds per year.

Air sampling conducted during the investigations at these subsites indicates that national standards for air quality are not exceeded. The highest recorded concentration of lead was 0.2 micrograms per cubic meter (ug/m^3), which is well below the national standard of 1.5 ug/m^3.

6.0 Summary of Site Risks

In conjunction with the Baxter Springs and Treece RI, a HHRA and an ERA were conducted by PRPs to evaluate the risks to human health and the environment that could result from exposure to hazardous substances. These reports which detail the screening level type assessments are contained within the Administrative Record file.

These screening level risk assessments were prepared using data from the subsites and from assumptions regarding maximum exposures that could be reasonably expected to occur for an individual or population at or near the subsites. This exposure is defined as the Reasonable Maximum Exposure (RME). The individual (or population in the case of the ERA) most likely to be exposed to hazardous substances is defined as the RME individual. The RME individual is used as a reference point in the risk assessment process to help determine what health related risks are present. The RME population is used as a reference point in the ERA in order to help determine the risks that are present.

6.1 Human Health Risks

When evaluating the risk resulting from exposure to hazardous substances for people at or near a Superfund site, EPA considers the exposure to be unacceptable if it results in a hazard index (HI) greater than one. A HI is a summary for a specific chemical across all pathways or a summary of all hazardous quotients (HQs) for a residential scenario. A HI of one or more indicates that adverse health effects are possible. Human health effects related to lead are assessed using EPA's Integrated Uptake/Biokinetic Model (IEUBK). The risk associated with lead is considered unacceptable if the IEUBK model predicts that lead levels in blood exceed 10 micrograms per deciliter (ug/dl) for the hypothetical child at a frequency greater than 5%. Children under six years of age are considered the major population at risk.

A lead and cadmium exposure study was completed by the Agency for Toxic Substances and Disease Registry (ATSDR) in January 1996 at the Cherokee County site. The study targeted the Galena subsite which is adjacent to the Baxter Springs and Treece subsites. The ATSDR exposure study demonstrated a 10.5% exceedance of blood lead levels above 10 ug/dl for the hypothetical child. The ATSDR study consisted of the actual collection of children's blood lead samples followed by analyses and comprehensive in-home assessments of several variables.

The IEUBK model was used to simulate exposure to lead and bases its calculations on children as they represent the most sensitive receptor group. If a given exposure does not pose a problem to children living in these subsites, then adults are assumed not to be significantly impacted. The complete IEUBK data output for the Baxter Springs and Treece subsites is presented in Appendix E of the HHRA report. The results from an IEUBK model run for OU-7 of the Cherokee County site are provided in Attachment #2 of this ROD. The attachment also contains an adult lead model run for the Baxter Springs and Treece subsites. The information in Attachment #2 was prepared by EPA. The IEUBK data in the HHRA (Appendix E) was prepared by the PRPs. The EPA models include institutional control assumptions and site specific information.

The results predicted by the IEUBK model indicate that the concentrations of lead currently present in soils at these subsites present an unacceptable risk to the children living in residences located on or near mine wastes. The concentration of lead in residential soils is the main concern for the uptake of lead and projected elevated blood lead levels under both current and future residential land use scenarios.

The HHRA report discusses the HIs and HQs relating to human exposure to onsite soil, water, and air, as well as human ingestion of beef, milk/dairy products, and produce. A HQ is a comparison of site specific chemical intake versus established intake levels that do not pose a health threat. HIs and HQs estimate potential health risks. Soil pathways generally dominate the risk characterization for the Baxter Springs and Treece subsites. Except in cases where residences are located on or near mine wastes within the Baxter Springs and Treece subsites, significant lead exposures are potentially unlikely to occur under current site conditions. Based on the onsite data and model default values, the human uptake of lead from air, water, and diet have a lesser impact on total lead uptake when compared to potential soil contributions.

These results are based on the premise that impacted groundwater is not being consumed and that recreational activities on/in impacted streams and bodies of water are not occurring. Although the impacted uppermost aquifer is not known to be utilized as a primary drinking water source at the present time, it may contaminate the lower aquifer, which is a primary water source, and it is also possible that shallow aquifer domestic or agricultural wells could be drilled in the future. Additionally, there may be rural users of the uppermost aquifer that have not been identified. Risks are also associated with the contact of surface water through actions such as boating, swimming, or fishing as well as impacts from the consumption of contaminated fish. In summary, non-soil pathways do not have a substantial known impact on predicted blood lead levels, but groundwater and surface water may be a pathway of concern under certain circumstances.

Lead is the only demonstrated human health risk at the site. However, cadmium has the potential to create an unacceptable risk resulting from the ingestion of vegetables or groundwater. Vegetables have been demonstrated to readily uptake cadmium and thus pose a potential health threat. Many studies at this multiple operable unit megasite have conclusively demonstrated human health risks. Additional human health risk studies can be found in the Administrative Records for OU-1, OU-5, and OU-7 of the Galena subsite.

6.2 Ecological Risks

Data collected during the investigations of both the Baxter Springs and Treece subsites indicate the contaminants of concern for ecological risk include cadmium, lead, and zinc. While zinc is not a contaminant of concern (COC) with respect to human health, it is a concern for ecological risk in addition to cadmium and lead. Cadmium, lead, and zinc exceed the Ambient Water Quality Criteria (AWQC) established by the Clean Water Act (CWA) in the streams of both subsites.

For aquatic organisms, a site specific surface water cleanup goal for each metal contaminant was derived by calculating a toxicity reference value (TRV). TRVs were developed by using site specific variables (e.g., hardness, pH) and are appropriate for use in calculating ecological risk because they are based on species found or expected to be present in these subsites. The following table compares the TRVs and AWQC:

Contaminant of Concern	AWQC - Chronic (mg/l)	TRVs (mg/l)
zinc	0.10599	1.423
cadmium	0.00113	.008
lead	0.00318	.027

The TRVs were compared to concentrations of the COCs in surface water at various exposure locations (stream or pond sampling stations). A ratio between the actual surface water concentration and the TRV was then calculated to assess the risk to the aquatic environment. This ratio is referred to as the toxicity quotient (TQ). For ecological risk, EPA generally considers risk to be unacceptable if the TQ is greater than one. A TQ of one or more indicates that adverse ecological effects are possible.

The investigation of these subsites included analysis of streams and ponds, which focused on assessing the risk to aquatic life utilizing the TRVs. The streams assessed included Tar Creek/Tar Creek Tributary (draining the Treece Subsite), and Spring Branch/Willow Creek (draining the Baxter Springs subsite). Refer to Figures 3 and the earlier text discussing the two separate subsites and associated watersheds or drainage basins that are addressed by this ROD.

Fish populations in lower Tar Creek within the Treece subsite were low, likely due to high zinc concentrations and marginal physical habitat. The TQ for zinc, based on the ratio of the TRV to average zinc concentrations in Tar Creek, was six. Toxicity quotients for the other metals were less than one.

Metal concentrations in Spring Branch (Baxter Springs subsite) indicate the potential for adverse effects to occur based on TQs for cadmium and zinc at values of ten and seven, respectively. Fish were collected during field surveys which yielded different age classes of only a single species. This may indicate that this single species is reproducing in the creek. However, this data is incapable of evaluating chronic, sub-lethal effects which are more significant to the viability of subsite species, including fish, than the acute effects evaluated. Additional factors such as acclimation of the aquatic species, speciation/bioavailability of the COCs, and frequency and pattern of occurrence of toxic conditions may be masking the toxicity of the metals of concern. Thus, while some field data may indicate that certain limited fish populations are seemingly tolerant of adverse conditions, the TQs indicate that non-acclimated organisms would be adversely affected. This condition limits the introduction and establishment of organisms in the affected habitats and serves to restrict the ecological structure and function of the system. This results in fewer and fewer types of organisms and less resilience in their trophic relationships.

Although the aquatic habitat in Spring Branch (Baxter Springs subsite) was rated as fair, this drainage is entirely contained within an area impacted by mining. The RI report indicates that seepage from Ballard Pond, currently used by a chat reuse facility, is likely a major source of cadmium to Spring Branch. Fish were not observed in Ballard Pond, which had a cadmium TQ of ten, and Pond TP-7 which had TQs for iron and lead exceeding one. The Ballard Pond is further discussed in the RI report.

Mean TQs for cadmium, lead, and zinc in Willow Creek (Baxter Springs subsite) were less than one, however, it should be noted that AWQC are exceeded for cadmium, lead, and zinc. Willow Creek drains the northern portion of the Baxter Springs subsite and the upper segments of the creek are normally dry during the summer. An additional Baxter Springs subsite factor that must be taken into consideration is mine shaft discharge effects. The Bruger Mine shaft occasionally discharges groundwater to Willow Creek, and when discharges occur, zinc concentrations in Willow Creek likely exceed a TQ of 1. The Bruger shaft is further discussed in the RI report.

The investigation conducted at both subsites also focused on identifying risk to terrestrial organisms. Three key site-specific species were selected to represent the terrestrial receptor groups at these subsites. The species selected were the barred owl, red tailed hawk, and mink. For terrestrial organisms, the potential for toxic effects was evaluated by comparing the No Observed Adverse Effect Level (NOAEL) data from the literature (for the same or similar organisms) to contaminant dose estimates for the species at these subsites. The Lowest Observed Adverse Effect Level (LOAEL) data were used when NOAEL data were not available. To quantitatively estimate doses, it was assumed that the terrestrial receptors were exposed to mine related metals by inhalation of fugitive dust, ingestion of mine wastes and soils, ingestion of surface water, and ingestion of vegetation or prey. The worst case and RME scenarios were used. Worst case was defined as the highest exposure that is reasonably expected to occur at a subsite and was based on using a combination of conservative (i.e., high bias) exposure assumptions and upper bound (95th percentile) data. The RME scenario used less conservative, more site-specific exposure assumptions and arithmetic mean concentrations of the contaminants. The exposure assumptions and exposure point concentrations (EPCs) used to quantify intakes are presented in detail in the ERA report.

Toxicological data measuring the chronic effect of metals in the key terrestrial species identified for the subsites were not available, but data for other related species were available. Therefore, toxicity data for surrogate species were used. LOAELs for surrogate species were used, along with uncertainty factors, to approximate TRVs for cadmium, lead, and zinc for the three key receptors. The TRVs represented the predicted no-adverse-effect dose. The dose calculations for all terrestrial receptors are presented in Appendix A of the ERA, and the exposure/intake assumptions are presented in Section 5 of the ERA report.

Results of the toxicity assessment for mink indicate that chronic adverse effects from exposure to cadmium, lead, or zinc are possible, since the worst case and RME TQs were equal to or slightly higher than one (range of one to three). These data indicate that terrestrial species which consume fish will likely experience adverse chronic effects from exposure to cadmium, lead, or zinc. The calculated TQs for two raptors were all less than one.

In summary, the ERA indicates that there is a significant and unacceptable risk to aquatic organisms present at these subsites. The risk to terrestrial organisms that eat fish is also considered to be unacceptable. Additionally, a number of assumptions in the ERA result in an underestimated level of risk. Examples of the under estimating of risk for aquatic receptors include the following: TQs were calculated with LOAELs instead of NOAELS which are approximately ten fold less stringent; mean chronic LOAELs were calculated from a range of values rather than using the most conservative LOAEL; sediment was omitted as an exposure pathway; concentrations reflecting potential for adverse effects on individuals were disregarded; and dissolved metals concentrations were adjusted using ratios based on stream-specific sampling data rather than assuming 100% availability of total recoverable metals. Underestimated levels of risk for terrestrial receptors include the same factors as for aquatic receptors with the addition of the most-likely-exposure (MLE) intake being estimated rather than using the RME intake. When considering the non-conservative ERA characterization yielded a determination of significant and unacceptable risk, this only serves to foster and emphasize the need for remedial action to be implemented.

7.0 Remedial Action Objectives

During the FS process, media specific Remedial Action Objectives (RAOs) were developed to address the unacceptable risks associated with each media and exposure pathway. These RAOs are goals for remediation that can be addressed through either reduction of exposures and/or reductions in contaminant levels. Two RAOs were developed for surficial mine wastes, four RAOs were developed for groundwater, and two RAOs were developed for surface water. These RAOs are presented on Table 1.

The RAOs were developed from the extensive amount of site specific information obtained during various phases of work conducted at the site. The RI provided site characterization information detailing the nature and extent of contamination in all media (groundwater, surface water, sediments, soil, mine wastes, air), the transport and exposure pathways of the various contaminants through the various media, and the detailed physical properties and nature of the media and contaminants. The potential risks and transport pathways for the COCs were evaluated in the HHRA for human receptors and the ERA for non-human (plants, animals, organisms) receptors or ecological assessment endpoints "biota". The RI, HHRA, and ECA are contained within the Administrative Record for the subject site.

The RAOs for the surficial materials or mine wastes (as presented on Table 1) are designed to prevent direct human contact with the wastes and thus eliminate the inhalation, ingestion, or dermal absorption of the site specific COCs. The elimination of the direct contact threat will ensure that the human health risks are reduced or eliminated. Specifically, the RAOs for source materials or mine wastes are designed to prevent exposures that result in excess cancer risks greater than 1.00E-06, a non-carcinogenic HI greater than 1.0, and elevated blood lead levels greater than 10.0 ug/dl for more than five percent of the child population. These RAOs also encompass soils that may be impacted by or contain mining wastes and also reduce or eliminate contributions to the groundwater and surface water systems. Additionally, the RAOs address ecological risks associated with the exposure of biota to metal contaminants.

The groundwater RAOs (see Table 1) are designed to prevent human and ecological exposure to contaminated groundwater as well as groundwater contributions to surface water that would result in unacceptable human and ecological risks. The groundwater RAOs will prevent the migration of contaminants from the upper shallow saturated zone (Boone aquifer) to the lower Roubidoux aquifer and thus prevent human health risks and exceedances of ARARs for the lower aquifer. The groundwater RAOs prevent the additional degradation of the Tar Creek Superfund site in Oklahoma and also are consistent with the past actions implemented by EPA Region VI at the Oklahoma Tar Creek Superfund site.

The RAOs for surface water (see Table 1) are also designed to prevent direct human contact with contaminants by eliminating ingestion, absorption, and inhalation pathways. The surface water RAOs will prevent the transport of contaminants through the streams (including stream sediments) in order to reduce or eliminate excessive ecological risks in the Neosho and Spring Rivers. The RAOs will prevent the exposure of aquatic biota to contaminants in order to reduce or eliminate excessive ecological risks.

8.0 Summary of the Alternatives

Eight basic alternatives were developed to address the RAOs in the FS report. Several of these alternatives included variations (sub-alternatives) for a total of 18 individual alternatives. The variations were designated by lettering such as 4a, 4b etc. Of these 18 alternatives, eight became candidates for additional detailed analysis. None of these original 18 FS alternatives or sub-alternatives were ultimately selected.

The EPA and the state of Kansas reviewed the PRP generated FS and initially proposed a modified version of Alternative 5a as a viable approach. Alternative 5a was not one of the eight alternatives carried forward for detailed analysis in the PRP derived FS. EPA and the state provided the PRPs with a modified version of Alternative 5a, known as "Modified 5a". In response to this input by EPA and the state of Kansas, the PRPs prepared an FS Addendum which detailed an alternative based on the Modified 5a Alternative and the original FS Alternative 3. This alternative is described in the FS Addendum and is designated as Alternative 3b. EPA has selected this approach, Alternative 3b, as provided in the FS Addendum, as the remedy for the Baxter Springs and Treece subsites.

Alternatives were analyzed based on the nine criteria for remedy selection in accordance with the National Contingency Plan (NCP). For purposes of clarity, only the selected alternative, 3b, and Alternatives 3, 5a, and Modified 5a will be discussed in the following evaluation and comparison sections. Table 2 provides a comparison of these four alternatives. It should be noted that the cost information on Table 2 is from the FS and FS Addendum documents and thus represents 1994 dollars. The FS was actually completed in 1993 and the FS Addendum in 1994; thus, all historic costs are considered to be in 1994 dollars for clarity. Updated costs for the selected alternative are presented later in this document. Attachment #3 contains a description of the original 18 alternatives for informational purposes. The FS and FS Addendum contain additional information discussing the original 18 alternatives, the Modified 5a Alternative, and the selected 3b Alternative.

9.0 Evaluation of the Alternatives and the Selected Remedy

The NCP, 40 C.F.R. Section 300 et. seq., requires EPA to evaluate selected remedial alternatives against nine criteria. A selected or preferred alternative must satisfy all nine criteria before it can be implemented. The first step is to ensure that the selected remedy satisfies the threshold criteria. The two threshold criteria are overall protection of public health and the environment and compliance with ARARs. In general, alternatives that do not satisfy these two criteria are rejected and not evaluated further. However, compliance with ARARs may be "waived" if site specific circumstances warrant such a "waiver" as described in Section 300.430(f)(1)(ii)(C) of the NCP, 40 C.F.R. § 300.430(f)(1)(ii)(C). As described in detail in Section 9.2 herein, the selected remedy anticipates that certain ARARs will be waived based on technical impracticability.

The second step is to compare the selected remedy against a set of balancing criteria. The NCP establishes five balancing criteria which include: long-term effectiveness and permanence; reduction in toxicity, mobility, or volume achieved through treatment; implementability; short-term effectiveness; and cost. The third and final step is to evaluate the selected remedy on the basis of modifying criteria. The two modifying criteria are state and community acceptance. The local community and the state of Kansas have accepted and concurred with the selected remedy.

9.1 Overall Protection of Human Health and Environment

This criterion addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

The selected remedy, 3b, is summarized on Table 3 (also see Figure 2) and discussed in Section 10 of this document. It should be noted that this remedy specifies differing actions for the two separate subsites that are addressed by this single ROD. Most of the alternatives consisted of differing approaches for the two subsites which are located within different watersheds or drainage basins (see Figure 3). It should be noted that this ROD is primarily an ecological remedy designed to protect surface water, groundwater, and ecological receptors. However, there is a human health component associated with residential soils potentially contaminated by mining wastes. For estimating purposes, 25 residential properties are assumed to represent the number of affected properties. It should be noted that no properties have currently been determined as requiring cleanup, but the characterization is somewhat limited. Future remedial design investigations will provide additional information for the residential remedial action component.

The selected remedy primarily focuses on ecological protection of the environment through cleanup actions at the Baxter Springs subsite to reduce metals loading to Spring Branch and Willow Creek and through actions at both the Baxter Springs and Treece subsites that include the implementation of institutional controls and plugging of abandoned deep wells. Implementation of the selected remedy will reduce the risks identified for terrestrial organisms that consume fish within the Baxter Springs subsite, which were the primary ecological group identified at risk. Protection of aquatic organisms in the Baxter Springs subsite will be accomplished by reducing or eliminating metals loading to Spring Branch and Willow Creek through removal and capping of source materials. The RAOs for surficial materials are achieved at the Baxter Springs subsite by preventing terrestrial biota from exposure to metals contaminants in surficial materials. The groundwater RAOs are achieved by performing engineering actions in the Baxter Springs subsite and by implementing institutional controls and plugging abandoned deep wells in both the Baxter Springs and Treece subsites. Additionally, the groundwater RAOs are achieved by implementing a consistent remedial approach at the Baxter Springs and Treece subsites which compliments, and is supplemental to, the actions taken at the Tar Creek site in Oklahoma. The surface water RAOs are also achieved by reducing the exposure of aquatic biota to metals impacted surface waters at the Baxter Springs subsite.

In summary, the selected remedy will protect the earlier referenced species of concern by removing or capping the most highly impacted mine wastes and by reducing the metals loading to surface water bodies. These species are impacted by contact or consumption of metals laden water, or by consumption of other species which have been impacted by mine wastes. The remedy provides protectiveness by removing or capping and revegetating the most impacted wastes, and since wastes which are in contact with surface water bodies are prioritized for actions, protectiveness is also provided by reducing the loading of metals to surface water. The habitat will thus ultimately be greatly improved with only a required short-term disturbance of impacted habitat areas in order to complete the engineering actions.

This remedy will provide protection of human health by remediating current residential yards situated on or near mine wastes if these yards exceed EPA established action levels. Future residents will be protected through the implementation of institutional controls that will prohibit building on soils or mine wastes which exhibit concentrations of contaminants in excess of action levels. This will achieve the RAOs for surficial materials by preventing direct human contact by ingestion and/or inhalation of the site specific contaminants. Also, the institutional controls will prohibit use of the shallow groundwater for human consumption. The selected remedy will provide protection of the deep aquifer by plugging poorly constructed or abandoned wells installed within the deep aquifer. This aspect of the remedy achieves the groundwater RAOs by preventing risks associated with the potential domestic use of metals impacted groundwater and also prevents the downward migration of contaminated groundwater from the upper Boone aquifer to the lower Roubidoux aquifer. The remedy also achieves the surface water RAOs by preventing the transport of metals impacted sediment to off-site areas by reducing or eliminating the contributions from on-site sources.

The selected remedy does not include source containment/stabilization actions to improve surface water quality in Tar Creek due to technical impracticability. The technical impracticability aspects are discussed in Sections 10.0 and 11.1, herein, in addition to Attachment #4. However, considering all of the threats posed by conditions at both subsites, the risk reduction that will occur due to actions that will be taken to address them, and consistency with past actions at the Region VI Tar Creek site, the selected remedy does provide optimum overall protection of human health and the environment.

All four comparison alternatives for the Baxter Springs subsite (3, 3b, 5a, Modified 5a) provide protection of the aquatic environment through engineering controls and provide for a reduction of aquatic risk by removal of mine waste piles and impoundments in addition to excavation of outwash tailings in the

Baxter Springs subsite streams. Of the four Table 2 Alternatives, Alternative 5a offers the highest degree of aquatic protection through remediation of the largest sources of mine wastes that contribute metals loading to the subsite streams. Modified Alternative 5a is the next most protective remedy (overall) as it includes less mine waste pile and impoundment remediation and less channel improvements than Alternative 5a. Alternative 3b (the selected remedy) is more protective of the Baxter Springs subsite than the other three Alternatives (3, 5a, and Modified 5a) since it includes the greatest amount of actions (see Table 2) for the Baxter Springs subsite. The FS addendum estimates that Alternative 3b will reduce or eliminate 85% of the metals loading to the Baxter Springs subsite. Volume reductions of lead, cadmium, and zinc are estimated at 116, 115, and 15,200 pounds per year, respectively to the Spring River. However, Alternative 3b does not include cleanup actions for the Treece subsite due to technical impracticability.

All alternatives presented in the FS report and addendum, except Alternative 1 (No Action), address the potential current human health risk by remediation. The 5a, Modified 5a, and 3b Alternatives provide protection of human health through the implementation of institutional controls on the use of groundwater and control future residential development on mine wastes. Alternatives 3, 3b, 5a, and Modified 5a also provide some protection of human health by the remediation of varying amounts of mine wastes in existing residential areas and undeveloped mine waste areas.

9.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

This criterion addresses whether the selected remedy will meet ARARs of federal and state laws. Compliance with chemical-specific, location-specific, and action-specific ARARs is required of the selected remedy unless a waiver of an ARAR is justified. Based on conditions at both subsites, a justification for a waiver of certain ARARs is provided in this ROD.

The selected remedy will meet all federal and state location-specific and action-specific ARARs relating to the Baxter Springs subsite. These ARARs are listed in Section 11, herein. The action-specific and most of the location-specific

ARARs relating to the Baxter Springs subsite are not required for the Treece subsite because the components of the selected remedy for the Treece subsite are different, which include residential yard cleanup, if any, and institutional controls.

Action-specific ARARs for the Baxter Springs subsite include the Clean Water Act (CWA) regulations on storm water discharge from industrial activities such as inactive mining sites. Surface mine wastes contribute metals loading to the surface water bodies as a result of runoff generated by infiltration events as well as from erosion of the mine waste piles by subsite streams. The 5a, Modified 5a, 3, and 3b Alternatives (in Baxter Springs only) meet the requirements of the CWA regulations by reducing water pollution from runoff.

Chemical-specific ARARs are waived at both subsites due to technical impracticability. Chemical-specific ARARs are technically impractical to achieve because available technologies cannot achieve cleanup levels within a reasonable time frame due to limitations imposed by site characteristics, such as karst-like topography, mine voids, enormous mine waste piles and other sources of contaminants outside these subsites (adjacent mine waste areas). It is technically impracticable for cleanup actions at both subsites to achieve Safe Drinking Water Act standards in the shallow aquifer nor can the CWA standards be achieved in surface waters.

None of the alternatives evaluated in the Feasibility Study met chemical-specific ARARs established by the Safe Drinking Water Act (SDWA) and the CWA. These ARARs are listed in Section 2 of the FS Report. The NCP, 40 C.F.R. §300.430(e)(2) and Section 121 (d) of CERCLA, 42 U.S.C. §9621(d), require that remedial actions achieve a cleanup level equivalent to the Maximum Contaminant Level Goals (MCLGs) or action levels established under the SDWA and the AWQC established under the CWA, where such goals or criteria are relevant and appropriate under the circumstances. The AWQC established pursuant to the CWA are relevant and appropriate cleanup standards for protection of surface water at these subsites but, require a waiver based on technical impracticability as discussed below.

Residents in the Baxter Springs and Treece subsites are served by public water districts and the shallow groundwater is not typically used for drinking water due to its poor taste, therefore, MCLGs are not relevant and appropriate cleanup levels under the circumstances. The Maximum Contaminant Levels (MCLs) promulgated under the SDWA are relevant and appropriate for remediation of the shallow groundwater at the Baxter Springs and Treece subsites because the shallow groundwater may be used for water supply in the future and there may potentially be a limited number of unidentified rural residents that currently utilize the uppermost aquifer. MCLs are achieved in the current public water supply systems for the residents of the Baxter Springs and Treece subsites.

A waiver of the chemical-specific ARARs for the Baxter Springs subsite and the Treece subsite is required based on technical impracticability. The evaluation of cleanup technologies in the FS and FS Addendum indicate that the remedial technologies evaluated are not capable of achieving these ARARs within a reasonable time frame due to limitations imposed by site characteristics. The karst-like (conduit flow) geology and numerous mine voids at these subsites, in addition to the several square mile areal extent (28 square miles for both subsites), effectively eliminate the use of typical engineering controls for cleanup of the contaminated shallow aquifer. In addition, every mine waste pile that contributes heavy metal contamination to the surface waters cannot be removed from the subsites. About 4.3 million cubic yards of surface mining wastes contribute to surface water contamination at these subsites. No place exists that could practically handle that volume of mine waste nor would it be practical to excavate or handle that volume of wastes.

Further, chemical-specific ARARs for the Treece Subsite cannot be achieved in a way that would be compatible with the completed actions at the contiguous EPA Region VI Tar Creek Superfund site. It would be inordinately costly to remediate Tar Creek at the Treece subsite, and if such remediation were performed, the creek would be re-contaminated as it flows from Kansas into Oklahoma. In 1985, the EPA Selected Remedy for the Tar Creek Superfund site in Oklahoma determined that the Oklahoma portion of Tar Creek is irreparably damaged due to historic mining operations (no beneficial use designation). Thus, the Region VI remedy allows millions of tons of mining wastes to remain on the surface, which continues to contaminate Tar Creek. The total cost for Alternative 3b, the Selected Remedy, at the Baxter Springs and Treece subsites is approximately 7.1 million dollars (1997 estimate). The additional total costs for remediation of Tar Creek at the Treece subsite is estimated at approximately 65.5 million dollars, which is considered inordinately costly (1994 dollars). The total present worth value of the comprehensive remedy for both subsites was estimated at approximately 79 million dollars in 1994 (total estimated costs of 93.2 million dollars). The additional 65.5 million dollars for Treece subsite actions would improve the water quality in Tar Creek. However, it is uncertain whether, even if remediated, Tar Creek would achieve AWQC standards under the Clean Water Act.

9.3 Long-Term Effectiveness and Permanence

This criterion addresses residual risk and the ability of a remedy to maintain protection of human health and the environment over time, after remedial action goals have been completed. Factors that are considered include both the magnitude of residual risk remaining after implementation as well as the adequacy and reliability of controls used to manage treatment residuals or untreated wastes.

Long-term protection of the aquatic environment will be achieved by the selected remedy in the Baxter Springs subsite through reduction of metals loading to subsite streams. Outwash tailings will be excavated and placed in tailings impoundments, mine waste piles will be contoured and vegetated, caps on source materials will be maintained to ensure permanence, and the wastes will be placed above the saturated zone. In addition, stream diversion structures will be constructed and maintained to ensure adequate permanence and long-term effectiveness of the remedy. These actions will provide permanent, long-term protection of species of concern as well as their habitat. The selected remedy does not include engineered controls in the Treece subsite (Tar Creek), as based on a technical impracticability determination, as well as a desire to be consistent with actions conducted by the state of Oklahoma and EPA Region VI at the adjacent Tar Creek site.

Alternative 3 includes remedial action to reduce risk to the aquatic environment, but will not provide adequate effectiveness because large chat piles, excavated chat areas, and tailings impoundments will not be remediated (see Table 2). Alternative 3 differs from the selected alternative by only requiring removal of outwash material. EPA believes that the subsite streams will ultimately become recontaminated after remedial actions proposed in Alternative 3 are completed since significant sources near the streams will not be remediated. Alternatives 5a and Modified 5a are not as comprehensive in the Baxter Springs subsite but do include engineered actions for the Treece subsite. However, EPA has determined that it is technically impracticable and inconsistent to perform engineered actions for Tar Creek at the Treece subsite. The selected remedy (3b) addresses outwash material, tailings impoundments, and selected mine waste piles.

The selected remedy, 3b, will provide long-term and effective protection of human health by eliminating human exposure to the mine wastes and the contaminated shallow groundwater through implementation and maintenance of engineering and institutional controls (ICs) and the remediation of residential yards if deemed necessary. Again, 25 residential properties are currently estimated since no properties have been identified due to limited residential characterization to date. Alternatives 3, 5a, and Modified 5a also specified similar actions with regard to potential human health issues. If ICs are not put in place and maintained into perpetuity, the selected alternative will not provide permanent protection. However, EPA anticipates that a financial fund, included as a recommended component of the selected alternative and described in detail in the FS report, will encourage maintenance and enforcement of the ICs. The financial fund portion of the FS is provided in Attachment #5. Additionally, EPA is continuing health education activities throughout the county as part of several overlapping remedial actions completed at the Cherokee County, Kansas megasite.

Alternatives 5a, Modified 5a, and 3b will provide long-term effectiveness since significant sources that contribute metals loading to the subsite streams will be remediated. Alternative 3 does not achieve long-term effectiveness. The additional scope of Alternatives 5a and Modified 5a do not provide greater protectiveness than Alternative 3b. Tar Creek enters the Neosho

River in Oklahoma and the Neosho River meets TRVs. Given that the majority of Tar Creek impacts occur in Oklahoma, the Neosho River meets TRVs, and Tar Creek in Oklahoma is designated as non-recoverable (no beneficial use designation), any Tar Creek actions in Kansas would not be deemed to result in greater protectiveness or be technically practicable. Even the 93.2 million dollars (1994) FS Alternative 8a would not achieve TRVs in the entire Tar Creek drainage.

9.4 Reduction in Toxicity, Mobility, or Volume Through Treatment

This criterion addresses the degree to which a remedy employs recycling or treatment to reduce toxicity, mobility, or volume of the contaminants present at the site. This also includes how treatment is used to address the principle threats posed by the site.

Given the size (28 square miles) and magnitude of the volume of wastes present in these subsites, estimated to be 4.3 million cubic yards, treatment of the wastes is impracticable. The selected remedy does not utilize treatment technologies to reduce the toxicity, mobility, or volume of the wastes, but will, however, reduce the toxicity and mobility of contaminants that threaten subsite streams by excavating outwash materials and capping the mine wastes. A reduction of toxicity and mobility will also be accomplished through construction of diversion structures and channel improvements to eliminate erosion of the waste piles as well as draining, filling, recontouring, and revegetating selected tailings impoundments. Additionally, remediation of the Bruger shaft discharges also will reduce the mobility/transport of metals contamination in the groundwater to the surface water. Remediation of residential areas, if required, will also reduce toxicity. Treatment methods and waste volume reduction were not considered practical and were not contained within any evaluated remedy.

Alternative 3 reduces the mobility of wastes available for exposure to aquatic organisms, but does not effectively eliminate the exposure. Alternatives 5a, Modified 5a, and 3b reduce the mobility of mine wastes to levels that would result in protection of both people and the environment. Alternative 3b provides the greatest mobility reduction for the Baxter Springs subsite while Alternatives 5a and Modified 5a provide greater overall reductions since they include engineered actions for Tar Creek (Treece subsite). However, the greater overall reductions afforded by 5a and Modified 5a (Treece subsite) do not increase protectiveness.

9.5 Implementability

This criterion addresses the technical and administrative feasibility of the selected remedy, including the availability of materials and services. The difficulty of undertaking additional action, if necessary, is also assessed.

The selected remedy is anticipated to be fully implementable. The engineering controls involve standard earth moving, capping, and construction techniques commonly employed. Institutional controls are commonly used at Superfund mining sites due to the unusually large volume of wastes requiring cleanup and the large areas contaminated by mine wastes. The EPA and KDHE will assist in implementation of the ICs by providing advice and support to local communities on adoption and implementation of ICs. A financial fund, proposed as part of the remedy, will provide incentive for establishment and maintenance of ICs.

All Alternatives evaluated in the FS report are considered to be fully implementable since they are general commonly used construction techniques.

9.6 Short-Term Effectiveness

This criterion addresses the period of time needed to achieve the remedial action, and any adverse impacts to human health and the environment that may be posed during implementation of the remedy.

It is anticipated that the proposed remedial action would be completed in approximately one year followed by continued long-term operation and maintenance (O&M). Any potential short-term risk to workers, the communities, or the environment would be readily preventable. Impacted habitat will be disturbed for a brief time period in order to perform construction activities. However, the ultimate beneficial gain clearly outweighs any minor short-term disturbances. If during the remedial action it becomes necessary to discharge impounded water to the on-site streams, all discharges will comply with the substantive requirements of the CWA.

All alternatives have short-term risk associated with the respective proposed actions, such as increased exposure to workers performing the remedial action or increased contaminant runoff into the subsite streams. However, it is anticipated that all short-term risks associated with the alternatives can be reduced through construction controls in order to prevent harm.

9.7 Cost

This criterion addresses the direct and indirect capital cost of the selected remedy in addition to annual O&M costs. It must be noted that all historic costs reflected in the proposed plan and FS Addendum are estimates in 1994 dollars. The FS was completed in 1993 but the costs are considered 1994 dollars since the information was utilized in the 1994 FS Addendum and proposed plan. An annual engineering cost index of 3.5% was utilized to approximate 1997 dollars for the selected alternative. It should also be noted that the proposed plan, FS, and FS Addendum discuss costs in terms of present worth value (1994) and total estimated costs. For purposes of clarity, this document will only discuss historic (1994) and current (1997) costs in terms of total estimated costs.

With regard to the selected remedy (Alternative 3b), the current cost is estimated at approximately 7.1 million dollars (see Table 4). Annual O&M is estimated to cost $140,000 per year (original 1994 dollar estimate). O&M costs have not been converted to 1997 dollars due to past questions regarding the determination of these costs. Historic O&M estimates may be biased high and are thus not increased in this document. A potential residential component of the 1997 cost is estimated at $721,744. Maintenance of the ICs will be provided by a financial fund component of the remedy as proposed by the PRPs in the FS. However, as with any type of ICs, the financial fund concept must be adopted and supported by local officials and citizens. As previously referenced, the financial fund is provided as Attachment #5.

With regard to a comparison of costs between the selected remedy and Alternatives 3, 5a, and Modified 5a; Alternative 3 is estimated to cost $9,270,189 with an annual O&M cost of $140,000 for the first five years. O&M costs for subsequent years are expected to be approximately $37,000 per year for monitoring of the remedy. Alternative 5a is estimated to cost $19,559,387 while the O&M component is estimated at approximately $140,000 annually for five years. Modified Alternative 5a is estimated to cost $13,361,000 with annual O&M costs of approximately $100,000 for the first five years. Please note that this paragraph presents the costs as originally stated in the FS, FS addendum, and technical documents (1994 dollars). As previously referenced, Table 2 provides a summary of Alternatives 3, 3b, 5a, and Modified 5a which includes cost data.

For informational purposes, the high estimate was Alternative 8a which was estimated to cost $93,156,430 with an annual O&M cost of $1,500,000 for the first eight years. O&M costs for subsequent years are expected to be approximately $37,000 per year for monitoring of the remedy. As previously discussed, Tar Creek remediation was estimated at $65,526,433 for Alternative 8a. The lowest estimate was Alternative 1, estimated at $38,400 to $43,000 annually for monitoring. Again, these costs are in 1994 dollars.

The selected remedy, 3b, is less expensive than all of the 18 original alternatives except for Alternatives 1 and 2. The principal difference between the selected remedy and Alternatives 1 and 2 is that Alternatives 1 and 2 do not address ecological risks in any manner. The selected remedy is the least expensive surface water source addressing remedy (see Table 2) but provides the optimum balance between cost and protectiveness. The selected remedy provides the greatest amount of engineering actions at the Baxter Springs subsite when compared to similar Alternatives 3, 5a, and Modified 5a (Table 2). More expensive and comprehensive remedies are not expected to provide a significant increase in protectiveness thus their increased cost is unwarranted. The selected remedy is also consistent with past EPA actions in Regions VI and VII and is acceptable to the state of Kansas. In short, it provides the best balance of cost and protectiveness. As previously mentioned, Attachment #3 contains more information on the various alternatives.

9.8 State Acceptance

This criteria addresses the supporting Agency's (KDHE) preferences or concerns about the remedial action alternatives. The EPA is the lead Agency and has coordinated all site activities with KDHE throughout the project. The KDHE expressed reservations regarding alternatives that seek to remediate Tar Creek because of the presence of major downstream sources of metal loadings, the certainty of recontamination of the creek as it flows through Oklahoma, the unrecoverable designation of Tar Creek by the state of Oklahoma, consistency with past actions of EPA Region VI and the state of Oklahoma, and the cost effectiveness of such a cleanup. The KDHE has stated that it concurs with the selected remedy for these subsites. A copy of the KDHE concurrence letter is attached.

9.9 Community Acceptance

This criteria reflects EPA's perception of the community's preferences or concerns about the selected alternative. Community acceptance of the selected remedy was evaluated during the public comment period and at a public meeting held on August 25, 1994, in Baxter Springs, Kansas. The community is supportive of the selected remedy. The results of the community acceptance evaluation are presented in the attached Responsiveness Summary. Additionally, the community has remained informed due to the large amount of EPA work that has been completed, and is currently ongoing, at other subsites of the Cherokee County site and the adjacent Tar Creek, Oklahoma site.

10.0 Description of the Selected Remedy

The EPA is selecting Alternative 3b, presented in the FS Addendum, as the selected remedy. The selected remedy addresses the current and future human health risks at both subsites (Baxter Springs and Treece) and ecological risks at the Baxter Springs subsite. Ecological risks at the Treece subsite are not addressed by this remedy due to technical impracticability which is consistent with past EPA Region VI actions at the adjacent Tar Creek Superfund Site in Oklahoma and Region VII Operable Unit #05 actions at the Cherokee County site.

Attachment #4 contains additional information regarding the TI waiver. Section 12 of this document discusses modifications of the original 3b remedy.

The largest capital expense associated with the selected remedy consists of remediating source areas that contribute metals loading to the Baxter Springs subsite streams which drain to the Spring River. The selected remedy, which includes engineered actions for source materials (mine wastes), groundwater, and surface water, is described on Table 3 and is discussed below.

EPA has determined that it is technically impracticable to achieve the AWQC promulgated for the state of Kansas for all surface streams at these subsites. As part of the ERA and FS, TRVs were calculated for the streams located in the subsites. TRVs, in general, are site specific water quality values and were established as remedial goals in lieu of AWQC. The selected alternative is expected to achieve the TRVs in the Baxter Springs subsite streams, however, TRVs are not expected to be achieved in the Treece subsite.

The selected remedy does not include ecological remedial actions in the Tar Creek drainage basin in the Treece subsite. Tar Creek within Kansas is an ephemeral stream and approximately 65.5 million dollars (Alternative 8a total estimated Treece costs) would be required to reduce metals loading in the Kansas portion of the creek (Treece subsite). The total cost of Alternative 8a is estimated at approximately 93.2 million dollars. As previously discussed, the selected remedy is estimated to cost 7.1 million dollars (1997 estimate). None of the alternatives evaluated, other than complete removal of all mine wastes impacting Tar Creek (Alternative 8a), can assure that TRVs would be met and they would only be met in the relatively short section of Tar Creek within Kansas. Tar Creek would become recontaminated as it enters and flows through northern Oklahoma. Metals loading sources for Tar Creek in the Treece subsite (Kansas portion) are insignificant when compared to metals loading in the Region VI Tar Creek site (Oklahoma portion). EPA Region VI has completed a five-year review of the remedial action taken at the Tar Creek Superfund site in Oklahoma. That review was released in April 1994 and concluded the water quality of Tar Creek is affected by irreversible man-made conditions and cannot be economically remedied and that no further action should be taken to improve the surface water quality. Tar Creek is classified as a no beneficial use water body in Oklahoma. Additionally, Tar Creek empties into the Neosho River in Oklahoma and this stream meets water quality criteria or TRVs. Finally, the state of Kansas has expressed reservations regarding alternatives that seek to remediate Tar Creek, for all of the reasons listed above. Based on these facts, and in light of the nine criteria which EPA is mandated to consider in making remedy selection decisions, EPA has determined that actions to attempt to improve surface water quality in Tar Creek should not be taken as part of this remedial action. However, this action does not preclude EPA from taking action in the future. The Treece subsite and adjacent Tar Creek site will continue to be assessed over time by EPA. The three following subsections describe the components of the selected remedy.

10.1 Surface Water

Figure 2 illustrates the surface water components of the selected remedy and Figure 3 depicts the watersheds for both subsites. This remedy maximizes reduction of metal loadings to the Spring River from sources within the Baxter Springs subsite. Outwash tailings deposits, and mine waste piles identified as potentially significant (specific deposits, tailings impoundments, or piles identified in the FS as those that contribute quantifiable amounts of metals to streams) sources in the Baxter Springs subsite, will be addressed under this alternative. Also, appropriate source containment and drainage/erosion control measures will be implemented to prevent the release and deposition of additional mine wastes. These actions will protect species of concern and restore habitat. Surface water actions will not be implemented in the Tar Creek drainage system in the Treece subsite due to technical impracticability and conformance with past EPA Region VI actions at the Tar Creek Superfund Site in Oklahoma and Region VII actions at the Cherokee County Galena subsite (see Attachment #4).

In addition to controlling the discharges from the Bruger shafts, as discussed later in the groundwater section, the following specific surface water actions will be implemented under the selected remedy (refer to Figure 2 for the following sections):

1). Source Containment/Stabilization - Baxter Springs
Containment actions will be implemented to address surface water RAOs for Spring Branch and Willow Creek as follows:

- Tailing impoundments BT-2 (Section 2) and the Ballard ponds, BT-4, BT-6, BT-7, BT-8, and BT-9 in the Spring Branch drainage and BT-1 (Section 3) in the Willow Creek drainage will be drained, filled, regraded, recontoured, capped with soil/clay cover systems, and revegetated to prevent deposition of tailings in Spring Branch and Willow Creek during storm events. Approximately 28 acres of tailings, which are surface water loading sources, will be remediated under this action.

- Chat and excavated chat piles BC-12, BX-11, BX-29, and BX-31 in the Spring Branch drainage will be regraded, recontoured, and revegetated to reduce surface erosion. This action will affect approximately 83 acres of chat and excavated chat areas. Chat from BC-12 may be used as fill and capping material as appropriate.

2). Source Containment/Stabilization - Treece
No action.

3). Surface Source Removal - Surface Excavation with On-site Disposal - Baxter Springs

Outwash tailing deposits BOW-2 in Spring Branch and BOW-1 in Willow Creek will be excavated and removed. Materials excavated from BOW-2 will be placed in tailings impoundments BT-6, 8, and 9 and BOW-1 materials will be placed in tailings impoundment BT-1 (Section 3); these impoundments are designated to be filled and capped. An estimated 82,000 cubic yards (aerial extent of approximately 47 acres) of outwash tailings will be excavated and removed from the drainages.

4). Surface Source Removal - Treece
No Action.

5). Drainage/Erosion Controls - Baxter Springs.

Erosion controls will be implemented to reduce surface water transport of contaminants as follows:

- Mill waste and tailings erosion will be reduced through channelization of the existing streams and construction of embankments, dikes, rip-rapped channels, etc. in the reach of Spring Branch between BT-6 and BT-2 (Section 2) with particular emphasis on the reach through tailings pile BT-2 (Section 2); and in the reach of the south branch of Willow Creek between BX-16 and BX-17. Channel improvements and erosion controls will be implemented on approximately 2,500 linear feet of stream channel. Temporary sedimentation basins will be constructed at appropriate locations to reduce metal loadings during and immediately following site remediation. Two temporary basins will be constructed in Spring Branch and one in the south tributary of Willow Creek.

6). Drainage/Erosion Controls - Treece
No Action.

7). Collection and Treatment - Conventional Metals Precipitation. Impounded water displaced during remediation of tailing impoundments will be used for construction water and dust control to the maximum extent practical. Physical/chemical treatment will be performed as needed on any excess water prior to use or discharge. All such treatment will comply with ARARs for waste disposal. This applies only to the Baxter Springs subsite since surface water engineering controls are not planned at the Treece subsite.

10.2 Groundwater

The groundwater components of the selected remedy are designed to address all the groundwater risks and RAOs for both subsites through engineering controls supplemented by appropriate ICs. The following actions will be implemented under the selected remedy:

1). Groundwater Collection/Controls - Hydraulic Controls.

Control Mine-Water Discharges to Surface Water - Groundwater RAO No. 1 will be addressed by reducing or eliminating the intermittent mine water discharges into Willow Creek by controlling recharge to the mine workings in the vicinity of the Bruger shafts. This only applies to the Baxter Springs subsite as previously discussed. Surface water control and diversion technologies would be utilized to limit recharge to the Bruger workings, thereby controlling the periodic discharges. Other feasible technologies may be applicable to control the Bruger discharges including in-mine biological treatment for metals removal, or collection and temporary storage of mine discharges.

- If, during the remedial design phase, prevention of surface water recharge to the Bruger complex proves infeasible, Groundwater RAO No. 1 will be addressed through collection and storage and/or treatment of the Bruger discharges rather than through prevention of surface water recharge. One of the following collection, storage, and/or treatment methods will be implemented at the Bruger shafts, if prevention of recharge is infeasible (again, this is only applicable for the Baxter Springs subsite):

- Collection and Storage - Surface impoundments or standpipes will be constructed around the shafts to temporarily store periodic discharges. These structures will be designed as evaporation ponds or pipes that siphon or facilitate flow back into the workings when the water levels decrease.

- Biological Treatment - A long-term passive in-mine water treatment system may be engineered at the Bruger shafts to address the problem of metal laden mine water discharging to surface water. This type of treatment would involve the placement of an anaerobic rock filter containing an organic microbial food source in the mine workings to create conditions favorable for the growth of sulfate reducing bacteria. Metals would then be removed by sulfide precipitation and would be retained in an insoluble form in the filter material.

Control of Surface Recharge to the Shallow Aquifer - Groundwater RAO No. 2, preventing further degradation of conditions in the Tar Creek Superfund site as a result of actions implemented in the Baxter Springs and Treece subsites, will be addressed by not diverting surface flows into mine workings in hydraulic connection with the Tar Creek site during remediation efforts. The selected remedy also meets the groundwater RAO of being consistent or supplemental to past actions conducted by EPA Region VI and the state of Oklahoma at the Tar Creek site and EPA Region VII at the Cherokee County site.

Plugging of Abandoned Deep Wells and Grout Injection - Protection of the deep Roubidoux aquifer from possible downward transport of contaminants in shallow groundwater (Groundwater RAO No. 4) will be addressed by searching for and plugging abandoned or poorly constructed wells and/or boreholes connecting the deep and shallow aquifers located during the search. Plugging activities will be conducted in both the Baxter Springs and Treece subsites.

2). Institutional Controls - Groundwater Use Restrictions - Shallow Aquifer. Groundwater RAO No. 3, preventing human health risks due to domestic consumption of shallow groundwater, will be addressed through implementation of institutional water management strategies at both subsites. These restrictions can be implemented by requiring the Division of Water Resources to form a Intensive Groundwater Use Area (IGWUA) which will actually prohibit the future drilling of shallow water wells for domestic use within both subsites through legal and/or administrative restrictions on the installation of new domestic shallow wells. The local municipal and county governments will be encouraged to use the IGWUA to place restrictions on shallow groundwater usage. These restrictions will have the effect of requiring future residents to connect to existing Rural Water District supplies, thereby preventing human consumption of shallow aquifer and/or impacted mine water. The effectiveness of ICs are dependent upon the actions of local officials and citizens as well as support by KDHE.

3). Institutional Controls - Groundwater Management Programs - Deep Aquifer. Groundwater RAO No. 4, preventing ARARs exceedances in the deep aquifer as a result of downward migration of contaminants through leaking wells, may also be addressed through the IGWUA water management strategies. This program may be designed to monitor construction and implement strict design and construction standards for new deep wells within the Cherokee County Superfund site aimed at ensuring casing integrity and prevention of potential leakage between the shallow and deep aquifers. Such actions may be instituted through KDHE under the Groundwater Exploration and Protection Act and will require local support.

10.3 Source Materials

The source material components of the selected remedy were developed to prevent possible human exposures that could result in excessive risks or elevated blood lead levels. Risks to current residents will be addressed by source removal or containment while future exposures will be addressed by land use restrictions to meet applicable RAOs. The following actions will be implemented under the selected remedy:

1). Existing Development: While the selected remedy is predominantly an ecological action which addresses surface water, mining wastes, groundwater, and ecological receptors; current human exposure to surface mine waste will be evaluated and reduced through engineering controls if necessary. Initially, a search will be performed to identify all residences built on or within approximately 500 feet of mine wastes in both the Baxter Springs and Treece subsites. Additionally, a representative sampling of homes within the Treece community will be conducted due to their close proximity to mine waste piles and tailings impoundments (i.e. not specifically within a definite 500 foot boundary). The community of Baxter Springs will not require this degree of characterization but must also be evaluated in areas of the outlying city which are adjacent to the mining waste areas (western portion of town). This will consist of using maps and aerial photographs to identify houses located on or near mine wastes then subsequently verifying the locations in the field. After identification of potentially affected properties, soil samples will be collected or analyzed by field screening methods.

If soil samples exceed a residential remedial action level (risk management derived), of 800 ppm lead or 75 ppm cadmium, the yards from which the samples were obtained will be remediated.

Remediation of yards will consist of actions that include the following: capping the affected yard with clean soil; excavation of contaminated soil and replacement with clean soil; or relocation. The soil used for capping and backfilling must meet the criteria of not exceeding 240 ppm lead and 25 ppm cadmium. This criteria is the state of Missouri any-use soil levels and is acceptable to the EPA and the state of Kansas. The type of remedial action employed will depend on the level of contamination present in the yard soil, the physical layout of the yard and surrounding features such as sidewalks and roads, and the design of the individual homes with respect to location and elevation of windows and porches. Yards that are excavated or capped will be regraded and revegetated as near as possible to the original condition. Where excavation of yard soils at existing homes is required, the excavated material will be placed in tailings impoundments scheduled for capping as part of this proposed remedy. The maximum required depth of excavation, or amount of capping soil emplaced, will be one foot. Relocation may be determined as the optimum approach in certain instances.

2). Future Development: ICs will be established to control future residential development on or within approximately 500 feet of mine wastes, including areas containing mine waste fill materials. Residential development may occur on mine waste areas provided the future building site is remediated by placing one foot of clean topsoil over the area to be developed and by contouring the property to reduce erosion. A repository may be established and maintained as part of the Environmental Health Program, described below, for the disposal of soil from future development in mine waste areas.

If future development occurs on a mine waste area which has been capped as part of the selected alternative, the cap and grade must be maintained so as not to destroy the protective purposes of the cap. The cap is intended to protect aquatic life from erosion and runoff, and to also protect future residents from exposure to mine wastes containing hazardous substances in excess of action levels. Sampling of building sites will be required prior to development to ensure that homes or buildings are not constructed on soil exceeding action levels.

Remediation of future residential development sites shall be the responsibility of the property owner or other responsible party. The county will be encouraged to provide oversight and enforcement of these restrictions on future development through implementation of an Environmental Health Program. Appendix C in the FS report and subsequent text discuss ICs.

3). Action Levels: EPA has established action levels based on health criteria for metal contaminants in residential yards at 800 parts per million (ppm) lead, 75 ppm cadmium, and 23,000 ppm zinc. These action levels apply to both existing and future residences and are in conformance with a July 1996 Record of Decision for Operable Unit #07 of the Galena subsite. The use of these action levels for this operable unit constitutes a risk management decision by EPA to utilize the same clean-up criteria for all residential areas of the Cherokee County Superfund megasite which is divided into several subsites and operable units. Attachment #2 contains an IEUBK model run for Operable Unit #07 of the Galena subsite and an Adult Lead model run for the Baxter Springs/Treece subsites. The PRP IEUBK model run for the Baxter Springs/Treece subsites is contained within the Administrative Record.

4). Institutional Controls: The ICs will consist of an ordinance that the county will be encouraged to enact and enforce for the entire Cherokee County Superfund site in order to oversee and control future residential development in areas of surface mine wastes. The proposed ordinance will create an Environmental Health Program which will include specific requirements governing development in mine waste areas. Development within certain designated areas will be controlled through the filing of an application for an environmental occupancy permit. An authorized county representative will issue the permit upon a determination that the risks associated with exposure to mine wastes or contaminated groundwater have been reduced to acceptable levels. The goal is to enact and enforce ICs that are applicable for the entire county and thus include all response actions performed at various operable units or sub-areas of the county wide site.. As previously stated, ICs are subject to local approval and enforcement.

In addition, all areas subject to the Environmental Health Program will be identified on a map which will be available, filed, and recorded at the Cherokee County Recorder of Deeds Office at the county seat in Columbus, Kansas. This map will be recorded as soon as possible after implementation of the program. All mine waste areas located in the Cherokee County Superfund site will be affected by these institutional controls.

ICs will include a financial fund or similar arrangement to augment the Environmental Health Program. The funding mechanism will provide an incentive to the county to maintain the program into perpetuity and will fund the administration and enforcement of the program. The details of the financial fund are provided in the FS and Attachment #5. The financial fund is subject to local approval and enforcement as well as support by KDHE.

5). Monitoring Program: A monitoring program will be established to assess new construction of residences in these subsites, enforcement of the ICs, and any distributions from the financial fund.

Operation and Maintenance

An operation and maintenance (O&M) program will be established to maintain the capped areas and stream diversion structures at the Baxter Springs subsite and to monitor the streams and enforce ICs at both the Baxter Springs and Treece subsites. Stream monitoring will include metals analysis and periodic biological/ecological assessment. The level of required maintenance will likely decrease as the capped and vegetated areas become more established. Embankments, ditches, and dikes will require some degree of O&M efforts as a result of erosional processes. A monitoring program for both subsites will be established to assess the effectiveness of the remedial action implemented to protect the streams in the Baxter Springs subsite and to monitor Tar Creek in the Treece subsite. Reports detailing groundwater and surface water analytical results, biological/ecological assessment, the efforts conducted for maintaining the capped areas and stream diversion structures, and the maintenance of ICs will be submitted to EPA and KDHE on an annual basis. The O&M monitoring may also include the collection and analysis of biological samples. One annual report will detail all of the various O&M efforts for both subsites.

Five-Year Review

A five-year review is required at sites where contamination remains above health based criteria. The review will be conducted in accordance with applicable guidance and Section 121(c) of CERCLA, 42 U.S.C. §9621(c), as amended.

The five-year review of the selected remedy will be conducted by EPA to ensure that the remedy is effective and accomplishes the goals of the remedial action. The five-year review will include an assessment of the groundwater and surface water monitoring information, the results of any biological or ecological sampling, and the enforcement and maintenance of ICs. The ICs prohibiting use of shallow groundwater for drinking water purposes and the enforcement of the controls on residential building will be assessed in addition to ICs that are protective of the capped and graded mine waste areas. During the five-year review, EPA Region VII will coordinate and consult with EPA Region VI and the states of Oklahoma and Kansas on the status of the Tar Creek Superfund site and the current water quality classifications of the affected streams, including Tar Creek and the Neosho River. Additional EPA actions at one or both subsites may result from the 5-year review process.

Cost

A detailed cost analysis of this remedy is provided in the FS Addendum (1994 dollars). The selected remedy is estimated to cost approximately 7.1 million dollars (1997 cost) with an annual O&M cost of $140,000. The cost estimate for the selected remedy is presented on Table 4.

11.0 Statutory Determinations

Under its legal authority, EPA's primary responsibility at Superfund sites is to undertake remedial actions that achieve adequate protection of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete, the selected remedial action for the site must comply with applicable or relevant and appropriate environmental standards established under federal and state environmental laws, unless a statutory waiver is justified. The selected remedy also must be cost effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

The selected remedy will protect human health and the environment by achieving the RAOs through a combination of engineering measures and ICs. Existing human health risks due to potential exposure from soils and mine wastes will be reduced by remediating residential yards situated on or near mine wastes where action levels are exceeded. Future risks to human health will be reduced by implementation of ICs that prohibit residential construction on soils or mine wastes with contaminant levels in excess of action levels and will additionally prohibit use of the shallow aquifer for domestic consumption. Also, the likelihood of future contamination of the deep aquifer, which is the source of the public drinking water supply for residents at the site, will be reduced by plugging abandoned deep wells and boreholes which connect the deep and shallow aquifers.

The selected remedy protects the environment by implementing measures designed to reduce metal loadings to Spring Branch and Willow Creek of the Baxter Springs subsite and by plugging abandoned deep wells in both the Baxter Springs and Treece subsites. Mine water discharges from the Bruger shafts (located in the Baxter Springs subsite) to surface waters will be controlled, tailings impoundments and chat piles that contribute significant amounts of metals to the streams will be contained/stabilized, outwash tailings that contribute significant metal quantities will be excavated and removed, and surface water contamination due to mill waste and tailings erosion will be reduced through channelization of the existing streams and construction of embankments, dikes, and rip-rap lined erosion controls. Implementation of these measures is expected to reduce metal loadings to Spring Branch and Willow Creek (Baxter Springs subsite) to levels below TRVs, which are the environmentally protective RAOs for surface water cleanup at the site. The reduction of metals in various media will provide protection to species of concern and restore habitat.

The selected remedy does not include actions designed to improve surface water quality in the Tar Creek drainage basin in the Treece subsite due to technical impracticability. Downstream sources of contamination in Tar Creek contribute significant metals loadings which are predominantly responsible for exceedances of AWQC. None of the alternatives evaluated, other than complete removal of all mine wastes impacting Tar Creek, can assure that the TRVs would be met, and they would only be met in Kansas. The estimated cost of complete Tar Creek remediation is approximately 65.5 million dollars (1994). Furthermore, Tar Creek would become recontaminated as it enters and flows through northern Oklahoma (Tar Creek Superfund site). The EPA regional office in Dallas, Texas, (EPA Region VI) responsible for Superfund sites in the state of Oklahoma, released an April 1994 five-year review report of the remedial action taken at the Region VI Tar Creek Superfund site in Oklahoma, downstream from the Treece subsite. This report supported the past actions taken at the site and concluded that the water quality of Tar Creek is permanently impacted by irreversible man-made conditions and cannot be economically remediated in a technically practicable manner. Tar Creek is classified as a no beneficial use water body. Region VI determined that no further action should be taken to improve the surface water quality in the Oklahoma portion of Tar Creek. In short, because of downstream conditions beyond the boundaries of the Cherokee County, Kansas site, and the substantially greater metals loading in the Oklahoma portion of Tar Creek as compared to the Kansas portion of the drainage, there is no manner that remedial action in Kansas (Treece subsite) can cost-effectively achieve a significant reduction of environmental risks in the Tar Creek drainage basin, and efforts to do so are considered technically impracticable.

In addition, the state of Kansas has expressed reservations regarding alternatives that seek to remediate the limited portion of Tar Creek that flows through the Treece subsite, for all of the reasons listed above. EPA has determined that actions to attempt to improve surface water quality in Tar Creek should not be taken as part of this remedial action because of the downstream sources of metals contamination that would not be affected by any remedial action at the Treece subsite, the severely degraded downstream condition of Tar Creek, the major impacts to the creek being from the Oklahoma portion of the drainage, decisions by EPA Region VI and the state of Oklahoma, and the state of Kansas' reservations about remediating this portion of Tar Creek. Additionally, the Neosho River receives Tar Creek in Oklahoma and continues to meet TRVs or water quality criteria. However, if new information regarding the Tar Creek site in Oklahoma is discovered or if any information indicates that the selected remedy is not protective of human health and the environment, EPA may re-evaluate the selected remedy. Such re-evaluation for the Treece subsite may be likely in the event that Kansas or Oklahoma upgrade the classification of Tar Creek under the Clean Water Act. All actions under this ROD will be evaluated at a minimum of every five years in accordance with the statutory requirement under CERCLA for five-year reviews.

The selected remedy will address the human health threats posed by conditions at both the Treece and Baxter Springs subsites. The selected remedy provides the best alternative remedial action for overall protection of human health and the environment. There are no short-term threats associated with implementation of the remedy that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the remedy.

Attainment of Applicable or Relevant and Appropriate Requirements of Environmental Laws (ARARS)

Whether the selected remedy will comply with applicable or relevant and appropriate chemical-, action-, and location-specific ARARs, is discussed below. Compliance with ARARs is required of the selected remedy unless a waiver of an ARAR is justified. This remedy includes waivers based on technical impracticability.

Chemical-Specific ARARs

The chemical-specific ARARs are identified and discussed in this section. Numerous heavy metals have been detected in the groundwater and surface water at both subsites. The elements of most concern are lead, cadmium, and zinc. Certain chemical-specific ARARs will be waived based on technical impracticability.

1. The Safe Drinking Water Act (SDWA), 42 U.S.C. § 300(g), National Primary Drinking Water Standards, MCLs, 40 C.F.R. Part 141, and the Kansas Administrative Regulations 28-15-13 for Safe Drinking Water are relevant and appropriate for this remedial action. MCLs are standards promulgated for the protection of public drinking water supplies serving 25 or more people. The EPA believes these levels are relevant and appropriate cleanup goals for contaminated groundwater where that water is currently or potentially a drinking water source. The groundwater should be cleaned up in accordance with these requirements because the shallow groundwater at the subsites is a potential drinking water source and the deep groundwater is a current drinking water source. The levels established by the Kansas regulations are similarly relevant and appropriate. The following list identifies the MCLs established by the SDWA and the state of Kansas drinking water standards for lead and cadmium: Pb-Action level = 15 ppb (at tap); Cd-MCL = 5 ppb. The selected remedy will not achieve the above listed MCLs in the shallow aquifer beneath the subsites. Thus, these ARARs are waived based on the technical impracticability of achieving MCLs in the shallow aquifer (as discussed previously in Section 9.2, herein, and see also Attachment #4). The technical impracticability (TI) waiver of chemical-specific ARARs criteria under the Safe Drinking Water Act is based on numerous factors including (1) the size of the Cherokee County Superfund site (115 square miles), (2) the huge volume of source materials (4.3 million tons of mining wastes within the Baxter Springs and Treece subsites), (3) the karst-like conduit flow characteristics and enormous size and amount of underground mine voids, and (4) consistency with prior EPA decisions regarding the Tri-State Mining District, of which Baxter Springs and Treece are only a part. For example, the Region VII 1989 ROD for the Galena subsite groundwater/surface water remedial action (operable unit #05) also used a technical impracticability waiver of the SDWA criteria for the same shallow

aquifer as in the Baxter Springs and Treece subsites. The TI waiver decision also is consistent with EPA Region VI actions at the adjacent Tar Creek Superfund site in Oklahoma. None of the remedial alternatives reviewed in the Feasibility Study and addendum could attain MCLs in the shallow aquifer at the Tri-State Mining District. The deep aquifer, however, currently meets MCLs at both subsites and will be protected by the institutional, hydraulic, and engineering controls that are an element of the selected remedy.

2. EPA Superfund guidance dated January 15, 1993, entitled "Cleanup Level for Lead in Groundwater" recommends that a final cleanup level of 15 ppb lead in groundwater used for drinking purposes is protective. The guidance recommends the 15 ppb level as consistent with the action level for lead in drinking water established under the SDWA. This recommended final cleanup level is to be considered at the subsites. As with the MCLs, the selected remedy will not achieve the recommended action level for lead in the shallow aquifer beneath the subsites. The deep aquifer, however, currently meets the recommended cleanup level for lead and will be further protected by the institutional, hydraulic, and engineering controls that are an element of the selected remedy.

3. Secondary MCLs and MCLGs are to be considered in implementing this remedy. Secondary MCLs and MCLGs are standards for public drinking water supplies that only provide for the protection of taste, odor, and aesthetic qualities. Since these are not health-based criteria, they are to be considered as necessary to remediate the groundwater at the subsites. Secondary MCLs and MCLGs were published in 50 Federal Register 46936.

4. The Clean Water Act, 33 U.S.C. 1251 et seq., requires that states establish surface water quality standards protective of human health and the environment. Tar Creek and Willow Creek are classified streams under the Kansas standards (K.A.R. 28-16-28b et seq.). Both are designated for noncontact recreation and expected aquatic life use, and Willow Creek is designated additionally for food procurement use. As modified by the National Toxics Rule and subsequent federal regulations (60 FR 22228, May 4, 1995), the standards apply the following relevant criteria to Tar and Willow creeks: dissolved cadmium, 3 ppb;

dissolved lead, 11 ppb; total recoverable zinc, 412 ppb. Although the beneficial uses of the Spring Branch are not specifically delineated in the standards, the noncontact recreational and expected aquatic life uses (and, therefore, the criteria cited above for Tar and Willow creeks) are deemed applicable to the Spring Branch. The Kansas standards require that corrective actions be implemented to restore the designated uses of impaired surface waters and to provide for the return of the original surface water quality conditions (K.A.R. 28-16-28f(g)). Variances may be granted by the department based on regional socioeconomic hardship considerations, subject to the review and approval of Region VII, EPA.

EPA has determined that it is technically impractical to meet these chemical-specific ARARs at the Baxter Springs and Treece subsites, thus these ARARs are waived. The TI waiver of these standards is based on the huge volume of mine wastes at the subsites and other factors described previously in Section 9.2 herein. The TI waivers for the chemical-specific ARARs for the selected remedy are fully supported by this ROD, the associated Administrative Record including the RI and FS reports, and prior EPA/State decisions regarding the Tri-State Mining area.

Location-Specific ARARs

The location-specific ARARs that will be attained by this remedial action are based on the location of the subsites and the affect of hazardous substances on the environment at the subsites. The following describes the location specific ARARs.

1. Executive Order 11988, Protection of Flood Plains (40 CFR 6, Appendix A) is a legally applicable requirement for this remedy. Portions of the subsites fall within the Spring River floodplain and therefore, the area is included within the scope of this executive order, which applies to government actions. It requires that such actions avoid adverse effects, minimize potential harm to floodplains, and restore and preserve the natural and beneficial values of floodplains to the extent possible. The selected remedy is expected to attain this requirement.

2. The Endangered Species Act, 16 U.S.C. Section 1531; 50 CFR Part 200; 30 CFR Part 402; and the Kansas Non-game and Endangered Species Conservation Act, KSA 32-501, are legally applicable requirements for these subsites. Several species of endangered or threatened species are found within the subsites and the requirements of these acts and regulations are applicable for the protection and conservation of these species. The U.S. Department of Interior and the Kansas Fish and Game Commission will be consulted in implementing this remedy for the conservation of the endangered and/or threatened species and habitat found within the subsites.

3. Executive order 11990, Protection of Wetlands, 40 CFR 6, Appendix A, is a legally applicable requirement for this remedy. This order requires the avoidance to the extent possible of adverse impacts associated with the destruction or loss of wetlands and to avoid construction in wetlands where practicable alternatives exist. Because some wetlands may be located within the subsites, this executive order is applicable, however, the selected remedy is not anticipated to interfere with or impact wetlands.

4. The Fish and Wildlife Coordination Act, 16 U.S.C. §661, 40 CFR §6.302 is a legally applicable requirement for this remedy. This requirement protects fish and wildlife from activities that might affect fish and wildlife habitat, such as diversion or rechanneling of a stream. The remedy includes channelization of streams in the Baxter Springs subsite and will be implemented in accordance with the substantive requirements of the Fish and Wildlife Coordination Act.

5. The National Historic Preservation Act, 16 U.S.C. §§470, _et seq_. and the regulation at 33 CFR Part 800 require that actions take into account possible effects on historic properties included on or eligible for the National Register of Historic Places. Since mining activities occurred over 100 years ago, this requirement is to be considered in the implementation of this remedy in order to preserve possible historic property which may be encountered at the subsites. Although unlikely, certain mining property may remain in such condition that historic preservation may be desirable. When practicable, consideration will be given to proper historic preservation if such mining property is found during implementation of this remedy.

6. The National Archeological and Historic Preservation Act, 16 U.S.C. §469, and 36 CFR Part 65 require recovery and preservation of artifacts which may be discovered during government actions. This requirement is to be considered in the implementation of this remedy in order to preserve artifacts which may be found at the subsites. The remedial action includes removal and placement of surface mine wastes at the Baxter Springs subsite. This activity may reveal significant scientific, prehistorical, historical, or archeological data (prehistorical Native American burial grounds and villages or historical mining camps could be discovered, although not likely). Therefore when practical, consideration will be given to preservation if such artifacts are found during implementation of this remedy.

Action-Specific ARARs

The action-specific ARARs listed below will be achieved by the selected remedy. These ARARs are based on activities and technologies to be implemented at the subsites.

1. The National Pollutant Discharge Elimination System, Effluent Limitations, 40 CFR Parts 122, 125, and 440 are relevant and appropriate limitations for this remedial action. The regulation at 40 CFR Part 440 sets technology based effluent limitations for mine drainage from mining related point sources. The remedial action includes the removal and processing of mine waste rock and chat (mining/milling wastes) at the Baxter Springs subsite. Such activities are sufficiently similar to mining and processing of lead and zinc ore that the effluent limitations are relevant and appropriate in the event that mine drainage is generated during the implementation of this remedy. The substantive requirements of these regulations are expected to be met during the implementation of the selected remedy.

2. The Surface Mining Control and Reclamation Act, 30 U.S.C. §§1201, et seq., 30 CFR Part 816, Sections 816.56, 816.97, 816.106, 816.111, 816.116, 816.133, and 816.150 are relevant and appropriate for this remedial action. These requirements provide guidelines for the post mining rehabilitation and reclamation of surface mines. The activities that will be performed as part of this remedial action are similar to mining reclamation and these requirements are expected to be met by this action.

3. Kansas regulations, KAR 28-30-1, for construction, reconstruction, and plugging of water wells are legally applicable for this remedy. The selected remedy includes an investigation and, if necessary, reconstruction or plugging of deep water wells on the Baxter Springs and Treece subsites in order to prevent migration of contaminated shallow groundwater to the deep aquifer. The selected remedy is expected to meet this requirement.

4. Section 404 of the Clean Water Act, 33 U.S.C. §§1251 et seq., 40 CFR Part 230, and 231 prohibit discharge of dredged or fill material into wetlands without a permit. The selected remedy calls for the filling of tailings impoundments and subsidences with surface mine wastes. Some flooded subsidences may be considered "artificial wetlands" sufficiently similar to wetlands and the substantive requirements of Section 404 are, therefore, relevant and appropriate for this remedy.

5. Section 10 of the Rivers and Harbors Act, 33 U.S.C. §403, and related Regulations 33 CFR §§320, et seq., and Section 404 of the Clean Water Act, Regulations 40 CFR Part 125, subpart M are relevant and appropriate requirements for this remedy. These requirements prohibit the disposal of dredged and fill material into streams without a permit. The selected remedy includes stream channelization at the Baxter Springs subsite and the substantive requirements of Section 404 are expected to be met.

6. Deed restrictions are institutional controls that the state of Kansas and local governments will enforce to protect the integrity of the completed remedial actions. Restrictions to be considered in the implementation of this selected remedy include restrictions on future mining activities, water well construction, excavation of backfilled tailings impoundments and subsidences, and other construction in the areas affected by this remedy. The state of Kansas may consider establishing a Groundwater Management District program for the Baxter Springs and Treece subsites to limit the use of shallow groundwater for drinking water purposes, pursuant to Kansas Administrative Regulations 28-30 and K.S.A. 82a-1036.

7. The CWA regulates storm water discharges from industrial activities such as inactive mining sites. These regulations are applicable because surface mine wastes contribute metals loading to surface water bodies as a result of runoff generated by infiltration events as well as from erosion of the mine waste piles by subsite streams. The selected remedy component for the Baxter Springs subsite will meet the requirements of these regulations by reducing water pollution from runoff. The storm water discharge regulations are not applicable to the selected remedy for the Treece subsite because actions taken under this alternative have no impact on storm water discharge to Tar Creek.

Cost-Effectiveness

The selected remedy is cost-effective because it will provide overall effectiveness proportional to its costs while also being consistent with past EPA and State actions. The selected remedy will achieve all the remedial action objectives other than the RAO for Tar Creek surface water, and thus effectively reduce unacceptable risks to human health and the environment, at an estimated cost of 7.1 million dollars (1997 dollars). The selected remedy is the least expensive remedy that is protective of human health and the environment and complies with ARARs. Although Alternatives 1 and 2 are less costly than the selected remedy, neither of them include any actions to reduce ecological risk and they therefore do not meet the threshold criteria that remedies must be protective of human health and the environment. All of the remaining alternatives cost significantly more than the selected remedy, with only marginal increases in the degree of protectiveness. The most costly remedy (8a) was estimated at 93.2 million dollars (1994 total estimated costs).

Utilization of Permanent Solutions and Alternative Treatment Technology (or Resource Recovery Technologies) to the Maximum Extent Practicable

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost effective manner for this remedial action. Excavation and removal of outwash deposits will permanently eliminate those deposits as a source of metal loadings to the streams. Draining, filling, and capping tailings impoundments is a permanent action.

Regrading, contouring, and vegetating selected mine waste piles in addition to the rechannelization and stabilization of streams are also permanent actions. The remediation of impacted residential yards will permanently eliminate risk to children who live in such residences. Plugging the abandoned deep wells and boreholes will permanently reduce the likelihood of the deep aquifer becoming contaminated.

The selected remedy does not utilize alternative treatment technologies since basic engineering and construction techniques were deemed very effective and desirable. Resource recovery technologies were not deemed appropriate for this site.

Preference for Treatment as a Principal Element

The selected remedy effectively reduces risks through a combination of engineering and institutional controls, and thus does not satisfy the statutory preference for treatment as a principal element.

The principal ecological threats are from heavy metal loadings to surface waters. The volume of outwash tailings, mining wastes, and milling wastes which contribute metals to surface waters via erosion is extremely large (4.3 million cubic yards over 28 square miles) and treatment of this tremendous volume of wastes would be impracticable. These wastes can be reliably contained over a long period of time, and thus engineering controls are being used instead of treatment to reduce ecological risks.

The principal current human health threat posed by the subsites is exposure to contaminated soils in residential yards. There is no treatment technology that can reliably and cost effectively remediate large volumes of contaminated soils in place, and thus engineering controls such as capping or excavation/removal must be utilized to reduce these threats. Relocation may also be an effective alternative in some instances. The principal future human health threat is from potential consumption of contaminated groundwater from a shallow aquifer well. The entire Cherokee County site is extraordinarily large (115 square miles), and implementation of an aquifer restoration remedy that treats contaminated groundwater would be impracticable. In addition, the shallow aquifer is currently not utilized as a source of drinking water in Baxter Springs and Treece.

12.0 Documentation of Significant Changes

Changes in this ROD include the modification of the residential action levels for lead and cadmium. It should be noted that the action level modifications only apply to potential residential yard excavations. The bulk of the work proposed under this ROD entails ecological work related to surface water, mine wastes, groundwater and ecological receptors. The specific mine waste piles, tailings impoundments, outwash tailings areas, and stream modification areas were determined during the characterization phase based on metals loading to surface and groundwater, thus; the FS Addendum action levels were tailored to the ecological work rather than primarily for potential residential or human health aspects of the remedy. The proposed plan indicated that the soil cleanup level for lead would be 500 ppm. The selected remedy specifies a residential lead action level of 800 ppm (800 ppm lead trigger level with excavation to 500 ppm or a maximum of one foot depth), which is protective of human health and is consistent with ongoing residential cleanup response actions at the Galena subsite of the Cherokee County site in accordance with the ROD for operable unit # 07. The cadmium criteria are also identical to the OU-7 ROD, 75 ppm cadmium trigger level with excavation to 25 ppm or a maximum depth of one foot.

The change in residential action levels is protective and is consistent with remedial action decisions made by EPA for the Tri-State mining area in July and August 1996. These decisions use 800 ppm lead as the trigger level for cleanup of residential yards, and are based on health studies conducted at the Galena subsite by the Agency for Toxic Substances and Disease Registry (ATSDR) and by the Missouri Department of Health (MDOH). These health studies analyzed residential children's blood lead levels. The 1995 ATSDR study conducted in Galena, Kansas (which is about 3 miles from Baxter Springs) found a significant human health risk from lead contaminated soils in residential areas. The 1994 MDOH study conducted in the Joplin, Missouri area (also near Baxter Springs) made similar findings. These studies, and other analytical data on childhood blood lead levels, formed the basis for Region VII's decision that the action level for residential yard cleanup in the Tri-State mining district should be 800 ppm lead. Although these studies and analyses were developed and considered after release of the proposed plan for Baxter Springs and Treece, Region VII has determined that because of the similarities between the Kansas and Missouri sites, both contiguous sites and the various operable units within these sites will use the same remedial approaches and cleanup action levels. EPA, Kansas, and Missouri are in agreement on the need for consistency in the approach to residential yard cleanup and that the 800 ppm lead level is protective. These actions thus constitute a risk management decision by EPA Region VII. The recent ATSDR and MDOH studies, in addition to the Galena OU-7 ROD, are included within the Administrative Record for the selected remedy.

In addition, EPA has determined that the investigation of mining wastes that may impact residential yards should not be limited to 500 feet from mining waste areas. The proposed plan set a 500 foot limit for investigation of residential areas near mining wastes or residences built on mining wastes. The selected remedy requires an evaluation and investigation of the community of Treece and the western area of Baxter Springs due to the close proximity of mining wastes to these residential areas. A strict criteria based on 500 feet within and construction on mine wastes will not be used for the selected remedy. This modification is necessary because residences need not be built "on" mining wastes or "within 500 feet" of mining wastes in order to be impacted by mining wastes. Such wastes may have been physically imported for construction, and erosion such as wind and water action may move waste materials a much greater distance than 500 feet. Herefore, implementation of the selected remedy for residential yard cleanup will be based on future design characterization information obtained from these areas. Areas will be characterized as necessary in order to determine if residential cleanups are required.

The potential remedial actions for impacted residential areas have also been expanded to include residential relocations as an option in addition to the historic capping and excavation/backfilling approaches. EPA believes that certain areas may be impacted to a significant degree, and when considering all site-specific circumstances, may justify residential relocation as a viable approach.

Changes in costs were also required since the past estimates were in 1994 dollars. Costs for the selected alternative have been updated to 1997 dollars.

KEY TO THE FOLLOWING FIGURES, TABLES, AND ATTACHMENTS

Figures

Figure 1 - Site Location
Figure 2 - Alternative #3b Engineering Controls
Figure 3 - Subsite Watersheds

Tables

Table 1 - Remedial Action Objectives
Table 2 - Summary of Four Alternatives
Table 3 - Alternative #3b Description
Table 4 - Alternative #3b Cost Estimate

Attachments

Attachment 1 - Responsiveness Summary
Attachment 2 - IEUBK Model Data and Information
Attachment 3 - Descriptions of Original 18 Alternatives
Attachment 4 - Technical Impracticability Waiver
Attachment 5 - Financial Fund Information

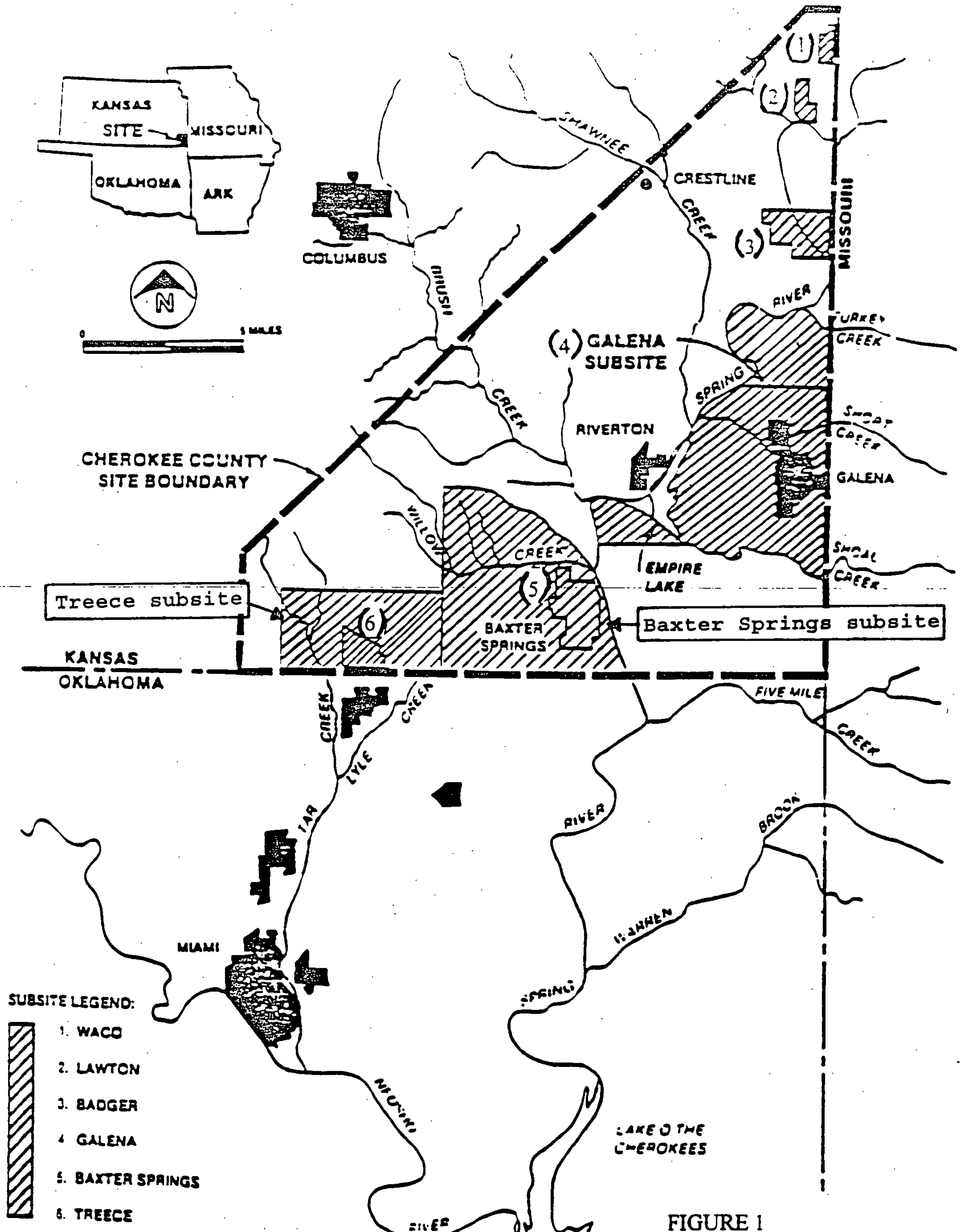


FIGURE 1

SITE LOCATION
CHEROKEE CO., KANSAS

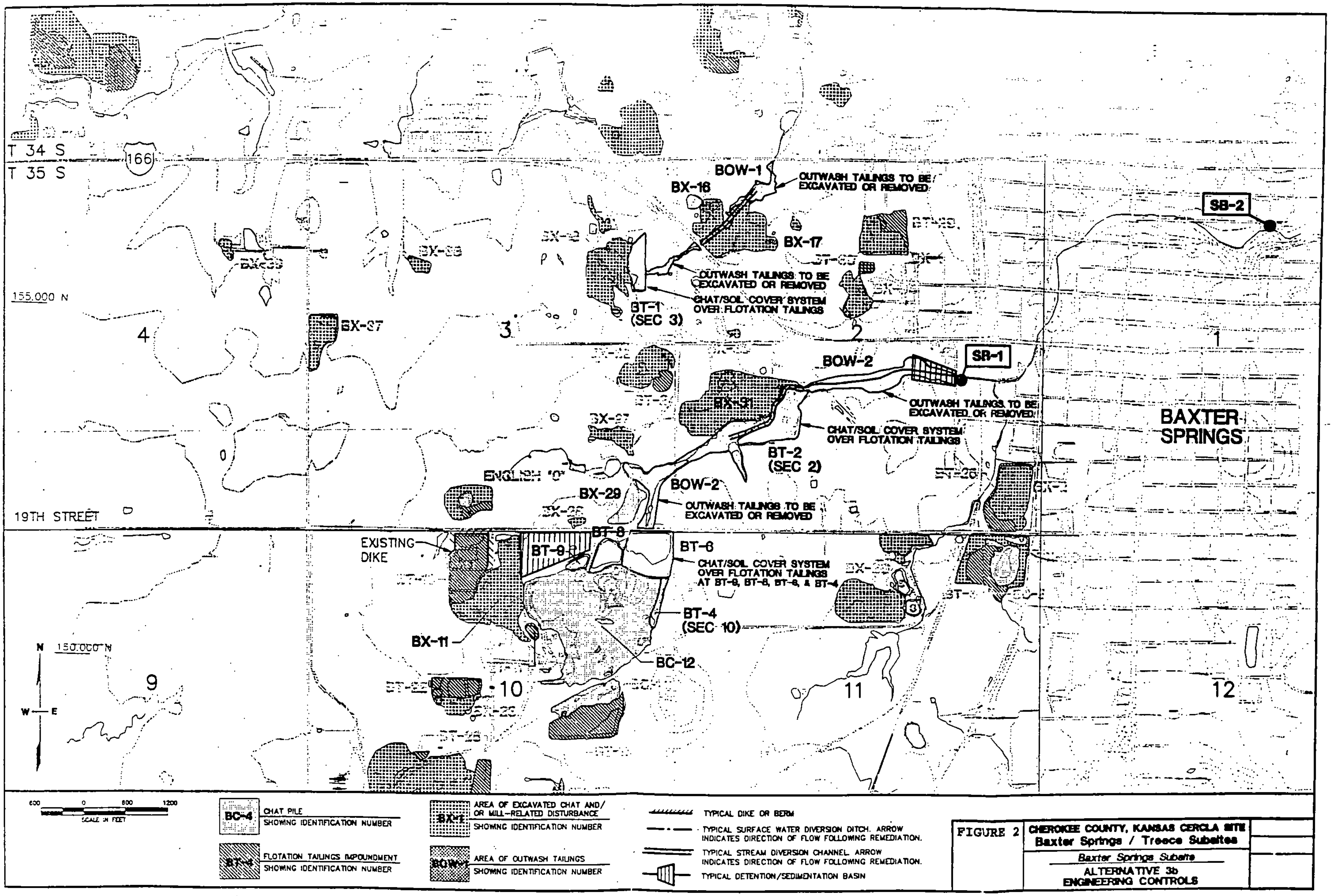
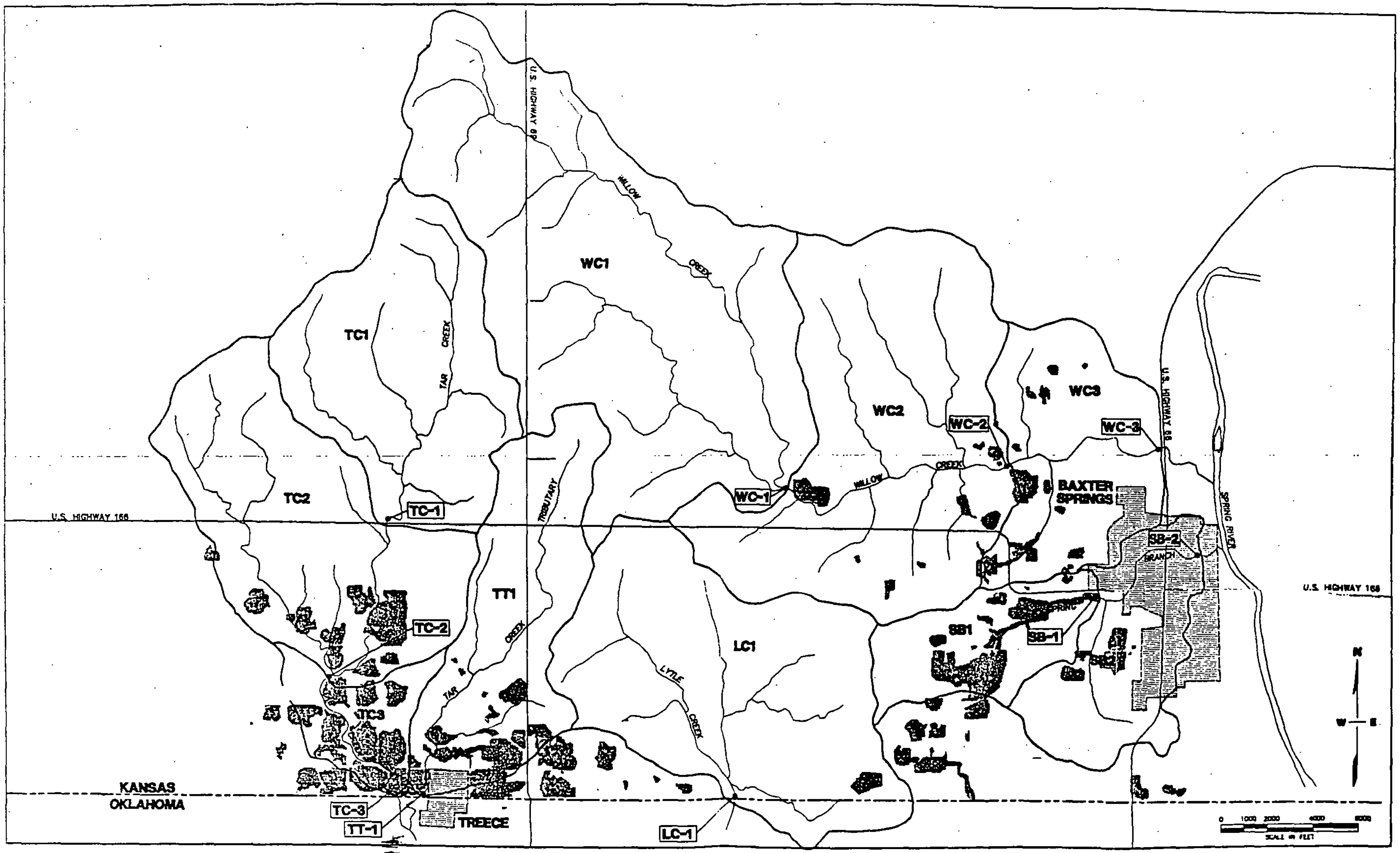


FIGURE 2 CHEROKEE COUNTY, KANSAS CERCLA SITE
Baxter Springs / Treece Subsites
Baxter Springs Subsite
ALTERNATIVE 3b
ENGINEERING CONTROLS



LEGEND

TT-1 — SURFACE WATER MONITORING STATION

WATERSHED BOUNDARY

MILL WASTE PILE BOUNDARY

FIGURE 3

CHEROKEE COUNTY, KANSAS, CERCLA SITE
BAXTER SPRINGS/TREECE SUBSITES

WATERSHED AND MILL WASTE LOCATIONS

TABLE 1

SUMMARY TABLE OF REMEDIAL ACTION OBJECTIVES BY MEDIA TYPE

REMEDIAL ACTION OBJECTIVES SURFICIAL MATERIALS	REMEDIAL ACTION OBJECTIVES GROUND WATER	REMEDIAL ACTION OBJECTIVES SURFACE WATER
1. Prevent direct human contact with, ingestion, and/or inhalation of metal contaminants of concern from on-site surficial materials that would potentially result in an excess cancer risk greater than 10^{-4}, a non-carcinogenic hazard index of greater than 1 or blood lead levels causing excessive health risks.	1. Prevent the release to surface water of ground water containing metal contaminants of concern that would result in exceedances of surface-water ARARs and excessive ecological risks in the Baxter Springs/Treece subsites.	1. Prevent the transport of metal contaminants and sediments containing metal contaminants from on site sources that would result in exceedances of surface water ARARs and/or excessive ecological risks in the subsite streams and the Spring and Neosho Rivers.
2. Prevent the exposure of terrestrial biota to metal contaminants in surficial materials that would potentially result in excessive ecological risks associated with bioconcentration of site contaminants of concern.	2. Prevent potential degradation of conditions in the Tar Creek Superfund site in Oklahoma resulting from implementation of remedial actions within the Baxter Springs or Treece subsites, and formulate remedial alternatives for the Baxter Springs and Treece subsites that would be consistent with and/or supplemental to actions taken for the Tar Creek site.	2. Prevent exposure of aquatic biota to metal contaminants in surface waters that would result in excessive ecological risks.
	3. Prevent risks associated with domestic usage of ground water supplies containing concentrations of metals exceeding appropriate ARARs for the Boone aquifer.	
	4. Prevent exceedances of appropriate ARARs resulting from the downward migration of metal contaminants of concern in shallow (Boone) ground water and/or mine water from on-site mining-related sources to the deep (Roubidoux) aquifer.	

TABLE 2
Summary of Alternatives 3, 3b, 5a, and Modified 5a

Alt.	Cost	Action	Baxter Spr.	Treece	Total
#3	9.3 MY	Outwash	47 acres	15 acres	62 acres
		Pile/imp	29 acres	25 acres	54 acres
		Channels	1,000 ft.	800 ft.	1,800 ft.
		Dike/emb	500 ft.	3,800 ft.	4,300 ft.
		Eros/div	500 ft.	500 ft.	1,000 ft.
#3b	5.9 MY	Outwash	47 acres	0 acres	47 acres
		Pile/imp	111 acres	0 acres	111 acres
		Channels	2,500 ft.	0 ft.	2,500 ft.
		Dike/emb	500 ft.	0 ft.	500 ft.
		Eros/div	500 ft.	0 ft.	500 ft.
#5a	19.6 MY	Outwash	47 acres	15 acres	62 acres
		~~Pile/imp~~	~~113 acres~~	~~450 acres~~	~~563 acres~~
		Channels	1,000 ft.	2,300 ft.	3,300 ft.
		Dike/emb	500 ft.	3,800 ft.	4,300 ft.
		Eros/div	500 ft.	500 ft.	1,000 ft.
#5a (mod)	13.4 MY	Outwash	47 acres	15 acres	62 acres
		Pile/imp	29 acres	215 acres	244 acres
		Channels	1,000 ft.	800 ft.	1,800 ft.
		Dike/emb	500 ft.	3,800 ft.	4,300 ft.
		Eros/div	500 ft.	500 ft.	1,000 ft.

Action Descriptions

Outwash - Excavation of outwash tailings followed by placement in tailings impoundments.

Pile/imp - Redistributing, regrading, countouring, and vegetating mine waste piles. Draining, filling, grading, contouring, and vegetating mine waste impoundments.

Channels - Rechannelization of streams.

Dike/emb - Construction of dikes and embankments.

Eros/div - Construction of erosion control, slope stabilization, and diversion structures.

* - Costs are in 1994 dolars

TABLE 3
Description of the Selected Remedy
Alternative #3b

Surface Water Actions - Baxter Springs subsite only

Source Containment/Stabilization: Drain, fill, regrade, recontour, cap, and vegetate tailings impoundments BT-1, BT-4, BT-6, BT-7, BT-8, and BT-9 (28 acres). Redistribute, regrade, recontour, and vegetate mine waste piles BC-12, BX-11, BX-29, and BX-31 (83 acres). These actions total 111 acres.

Surface Source Removal: Excavate outwash tailings BOW-1 and BOW-2 (47 acres). Place excavated material in tailings impoundments discussed above.

Drainage/Erosion Control: Rechannelization of 2,500 feet of existing stream channel of Spring Branch between mine waste piles BT-6 and BT-2. Construction of approximately 1,000 feet of dikes, embankments, erosion control, and diversion structures.

Collection and Treatment: Collect and treat impounded water displaced during implementation of the remedial action in the tailings impoundments. Discharge treated water to the ground surface for dust suppression during the remedial action.

Groundwater Collection/Controls - Hydraulic Controls
(Applies to one or both subites as indicated)

Control of Mine Water Discharges to Surface Streams: Construct surface water diversion structures in the vicinity of the Bruger shafts in the Baxter Springs subsite to control or contain mine water discharges from entering surface streams. Actions may include biological treatment and/or temporary storage of mine discharge water.

Control of Surface Water Recharge to the Shallow Aquifer: Construct surface water diversion structures during remedial actions at the Baxter Springs subsite in order to prevent surface water infiltration to mine workings which recharge the shallow aquifer.

TABLE 3 CONTINUED

Plugging of Abandoned deep Wells: Identify and plug any abandoned or poorly constructed wells that penetrate though the shallow aquifer into the deep aquifer. This action applies to both the Baxter Springs and Treece subsites.

Residential Source Material Actions - Both subsites

Surface Source Removal: Characterize the residential area of the Treece subsite and the rural residential area of the Baxter Springs subsite. Residential yards exceeding 800 ppm lead or 75 ppm cadmium will be excavated or capped. These action levels are risk management values which are used for all subsites and operable units of the Cherokee County site.

Institutional Controls - Both subsites

Ground Water Use Restrictions: Establish institutional controls through the Cherokee County Commission to prohibit domestic use of shallow aquifer water and limit use to agricultural purposes.

Ground Water Management: Establish institutional controls through KDHE or the Cherokee County Commission to regulate and monitor construction of deep aquifer wells within the Cherokee County site.

Future Residential Development: Establish institutional controls through the Cherokee County Commission to regulate the future construction of residential homes in mine waste areas. Controls will consist of an ordinance or permits which require residential yard soils to be sampled prior to construction in potentially impacted areas. Contaminated soils would require capping or removal prior to development.

TABLE 4
Cost Estimate for the Selected Remedy
Alternative 3b

Item Description	Baxter Cost	Treece Cost	Total
Surface Water Actions			
Outwash Deposits	$1,020,054	$ 0	$1,020,054
Piles/impoundments	$1,397,170	$ 0	$1,397,170
Stream Channelization	$ 512,782	$ 0	$ 512,782
Dikes/Embankments	$ 15,523	$ 0	$ 15,523
Erosion/Diversion	$ 12,052	$ 0	$ 12,052
Basins/Ponds	$ 215,458	$ 0	$ 215,458
Subtotal	$3,173,039	$ 0	$3,173,039
Groundwater Actions			
Deep Well Abandonment	$ 244,925	$ 653,132	$ 898,057
Bruger Shaft Actions	$ 97,567	$ 0	$ 97,567
Institutional Controls	$ 110,872	$ 110,872	$ 221,744
Subtotal	$ 453,364	$ 764,004	$1,217,368
Residential Actions			
Yard excavation/capping	$ 100,000	$ 400,000	$ 500,000
Institutional Controls	$ 110,872	$ 110,872	$ 221,744
Subtotal	$ 210,872	$ 510,872	$ 721,744
Indirect Costs			
Engineering Design	$ 224,236	$ 52,492	$ 276,728
Construction Management	$ 474,633	$ 111,109	$ 585,742
Contingency	$ 887,603	$ 207,783	$1,095,386
Subtotal	$1,586,472	$ 371,384	$1,957,856
Total Estimate	**$5,423,747**	**$1,646,260**	**$7,070,007**

* The FS and FS Addendum estimates of cost are in 1994 dollars. This table utilizes a 3.5% annual increase multiplier to covert historic costs to 1997 dollars.

* Additionally, the residential component assumes 25 homes total at $20,000 per home (5 homes/Baxter and 20 homes/Treece).

ATTACHMENT 1 - RESPONSIVENESS SUMMARY

RESPONSIVENESS SUMMARY FOR THE RECORD OF DECISION
Baxter Springs/Treece Subsites
Cherokee County, Kansas Superfund Site

This responsiveness summary is divided into the following sections:

Overview: This section discusses the public comment period, public meeting, and the public's view of EPA's preferred alternative.

Part I: Part I provides a summary of commentors' major issues and concerns, and expressly acknowledges and responds to questions raised verbally by the local community at the public meeting. The "local community" may include local homeowners, businesses, municipalities, and potentially responsible parties (PRPs).

Part II: Part II provides a comprehensive response to all written comments received and is comprised primarily of the specific legal and technical questions raised during the public comment period. As necessary, this section will elaborate with technical detail on answers covered in Part I.

Overview

The Proposed Plan and supporting documents included in the Administrative Record file were initially available for public comment from August 18, 1994, to September 16, 1994, and were extended for an additional thirty days of public comment to October 16, 1994. A public meeting was held on August 25, 1994, at 7:00 p.m. at the Community Center in Baxter Springs, Kansas. Comments received from the local community, both in writing and during the public meeting, were directed in general toward issues involving cost of the proposed remedy, rationale for the remedy, and specific questions regarding the proposed actions. The transcript from the public meeting is contained within the

Administrative Record file. The non-PRP local community did not express any adversity to EPA's recommended approach or indicate a preference for another approach or remedy.

NL Industries, Inc., a PRP at the Site, sent a letter to EPA during the public comment period stating their position that Alternative 2 in the Feasibility Study was the only remedy that would both address the risks posed by the Site and comply with the National Contingency Plan (NCP).

Gold Fields American Corporation, a PRP at the Site, sent a letter to EPA during the public comment period which stated their objections to the Proposed Plan and requested that the Administrative Record for the Baxter Springs and Treece subsites be changed in response to their comments.

A letter was submitted to EPA by Environmental Management Services Company (EMS) on behalf of the following PRPs: ASARCO, Inc.; Gold Fields Mining Corporation; NL Industries, Inc.; The Doe Run Company (St. Joe Minerals Corporation); Cyprus Amax Minerals Company, Inc.; and Sun Company, Inc., which stated both ~~their~~ general ~~and~~ specific ~~comments~~ concerning Proposed ~~Plan~~ statements they felt were questionable.

Part I: Summary of Commentors' Major Issues and Concerns

This section provides a summary of commentors' major issues and concerns raised during the public meeting followed by a response.

Question: A citizen asked for a comparison of heavy metals reduction in surface water between the 5.9 million dollar remedy and the 80.0 million dollar approach.

Response: The reduction of heavy metals in surface water at the Baxter Springs subsite is expected to be approximately 60 to 70 percent for the 5.9 million dollars remedy (1994 costs). The difference in the reduction of heavy metals between the 5.9 million dollar remedy and the greater reduction associated with an 80.0 million alternative is not thought to be warranted when considering the cost differential and the expected protectiveness of the 5.9 million dollar remedy. It should also be noted that the 5.9 million dollar remedy has now increased (1997 dollars) in cost to approximately 7.1 million dollars due to inflation and residential assumptions. Additionally, the 80 million dollar amount for the most protective remedy was the 1994 present worth cost, the total estimated cost was approximately 93.2 million dollars. The surface mine wastes that are not proposed for cleanup in the approximate 7.1 million dollar remedy (1997 estimate) are located in the Treece subsite and areas of the Baxter Springs subsite that are positioned away from the streams and are therefore not predominantly contributing metal loads to the Baxter Springs subsite streams. The selected remedy will address only those mine wastes directly contributing metal loads to the Baxter Springs subsite streams that are identified in the Feasibility Study Report and Addendum as the significant waste piles or areas contributing metals loading. The selected remedy does not address non-residential wastes in the Treece subsite due to technical impracticability, in other words, the high cost and nature of the problem do not warrant action at this time.

The primary difference between the approximate 7.1 and 93.2 million dollar (1994 total costs) alternatives is that, although both alternatives address significant contributions of metals to the Baxter Springs subsite streams, the 93.2 million dollar alternative would remediate all surface mine wastes in both the Baxter Springs and Treece subsites. However, the cost of this approach is not warranted when consideration is given to the fact that the streams draining the Treece subsite would immediately become re-contaminated as they cross the Kansas state line and enter Oklahoma. Past actions by EPA Region VI and the state of Oklahoma have determined that actions to remediate Tar Creek within Oklahoma are considered impracticable, thus it would be inconsistent to take a differing approach in the Kansas portion of the historic mining area, especially considering that the majority of the flow and impacts occur within Oklahoma.

Question: A citizen asked EPA to explain how it is determined that a particular mine waste area or pile contributes metals loadings to streams.

Response: During the past investigation, mine wastes and surface water samples were collected at various locations to determine metals loading. Streams were sampled at the head of the stream and at various points between downstream piles and waste deposits or areas. The concentration of metals and the flow velocity of the streams were measured along the various points and a calculation was then made of how many pounds of metals were passing each point in that particular part of the stream. Comparison of the data from various points along the stream indicated the locations where concentrations of metals increased, thus it was possible to determine the mine waste source areas or piles which contribute the major metals loadings to the streams.

Question: A citizen inquired about the Proposed Plan's intention to plug abandoned deep wells and wanted to know if the proposed alternative included filling all holes such as test boreholes. In addition, how will it be determined if wells or boreholes go through the shallow aquifer into the deep aquifer?

Response: The wells that will be plugged are wells that penetrate or go through the shallow aquifer (located near the ground surface to approximately 400 feet deep) down into the deep aquifer which is about 1,000 feet below the surface. The selected remedy does not require plugging all of the existing wells; if a well terminates in the shallow aquifer, it will not be plugged. Standard test boreholes are routinely plugged as part of standard field activities and should thus not pose a problem. The EPA and the state of Kansas acknowledge that the shallow aquifer is contaminated and cannot be practically remediated. However, plugging the deep wells will protect the deep groundwater by not allowing the contaminated shallow aquifer water to migrate to the deep aquifer. Historic boring records will be used to determine which wells penetrate the shallow aquifer.

Question: A citizen asked why the Treece subsite is still considered a part of the overall Cherokee County Superfund site if no clean-up will be performed at that subsite.

Response: Although engineering construction activities related to the mine waste areas are not planned for the Treece subsite, other types of work will be performed in Treece. Institutional controls consisting of health education, blood lead monitoring, and controlling future residential development in mine waste areas will be implemented in Treece in addition to testing and remediating residential yards impacted by mining wastes. Additional work may be conducted at the Treece subsite in the future if new remedial response actions are recommended by the states of Oklahoma or Kansas as well as EPA Regions VI and VII. New or previously unknown information or changing site conditions may facilitate new future actions. Thus, Treece remains an active part of the Cherokee County Superfund site and is included in all remedy aspects with the exception of engineering controls for mine waste source areas.

Comment: A citizen asked why no action is proposed for the Treece subsite; is Treece not important enough to cleanup?

Response: Action will be taken in Treece to protect human health in the form of institutional controls implementation and residential yard testing followed by subsequent remediation if deemed necessary. These are the same actions as for Baxter Springs. When determining the appropriate remedy to address contamination at a Superfund site, EPA is required by law to evaluate potential remedies using certain specific criteria. As a result of the evaluation of these criteria, the selected remedy includes identical actions to protect human health in both the Baxter Springs and Treece subsites, which is the same decision for protection of human health in the other subsites of the larger Cherokee County site. The difference in the selected remedy between Treece and Baxter Springs is that Tar Creek in Treece will not be subject to surface water cleanup in order to address ecological risks. This decision does not impact protection of human health in Treece.

EPA believes the benefit of remediating Tar Creek in the Treece subsite would be minimal because of the downstream contamination of Tar Creek (most of the contamination enters the creek as it flows through Oklahoma) and its classification by the state of Oklahoma as a stream that is irreparably damaged by manmade influences. At this time, EPA Region VI and Oklahoma have not proposed any engineering actions to remediate Tar Creek and have determined that it would be impractical to do so. The stream is classified as a no beneficial use water body. EPA and the state of Kansas have also determined that it would be technically impracticable at this time to conduct engineering actions for Tar Creek. However, if EPA Region VI or the state of

Oklahoma decide to modify the existing Tar Creek remedy in the future, EPA Region VII and the state of Kansas may also reconsider the remedial action decision for the Treece subsite and, as necessary, may propose a remedial action for the Treece subsite to address the ecological risk posed by the surface water contamination. EPA intends to be flexible and consistent in dealing with the entire Tar Creek watershed and feels that the current approach achieves those goals.

Question: A citizen asked if it was correct that EPA was not going to remove the tailings from the Treece subsite and also asked if EPA was not planning on remediating the gravel roads. The citizen expressed concern about children riding school buses on gravel roads.

Response: As discussed in the previous responses, the selected remedy does not include remediation of mine tailings in the Treece subsite. In addition, the selected remedy does not address the gravel roads in either subsite. Air monitoring in several locations along roadways within the subsites found no problems with the dust from an inhalation standpoint. No lead or any other metals were detected above national standards in the air monitoring program; thus, the gravel roads do not likely pose a significant inhalation health risk. EPA acknowledges that there may potentially be dermal risks to children under six years of age who come into contact with certain dusts from mining wastes used in road applications.

Question: A citizen questioned the manner in which EPA would be able to successfully plug wells where casing was installed in the well.

Response: It is a common procedure to plug wells and EPA has successfully performed this type of work at other subsites of the Cherokee County site. The remedial design documents will specify the actual methods by which the deep wells will be plugged. Wells are typically grouted or over-drilled and grouted as part of the plugging procedure.

Question: A citizen asked when tests of Willow Creek were conducted and whether they were performed during wet weather. The citizen also asked if water flowing off the gravel roads was tested.

Response: During the remedial investigation, samples were collected from Willow Creek on a quarterly basis for one year; taken in February, May, August, and November/December of 1993. Runoff samples from gravel roads were not collected.

Question: A citizen asked the following questions concerning the surface mine waste piles: 1) are some piles in the Baxter Springs area contaminated while others are clean; 2) will each pile be dealt with individually; 3) what is considered the definition of a pile, how high?

Response: To the extent that the surface mine waste piles will be addressed by the selected remedy, each individual surface mine waste pile or area (tailings impoundments, outwash deposits, etc.) will be dealt with individually because each area varies substantially. Some piles or areas have low concentrations of metals, do not impact ecological receptors, and do not require cleanup. Other piles have higher levels of contaminants, impact receptors, and thus require cleanup. The specific piles and other mine waste areas (tailings impoundments and outwash deposits) requiring cleanup are identified in the Record of Decision (ROD) and the Feasibility Study Addendum. The term "pile" is generic. Surface mine waste piles include piles as tall as 200 feet and range downward to relatively planar areas that are approximately six inches high and spread over a large area.

Question: A citizen asked what amount of material will be removed and where will it be taken?

Response: The excavated mine wastes will be placed into existing tailing impoundments at the Baxter Springs subsite for consolidation, grading, capping, and revegetation. Nothing will be hauled off the Cherokee County site and deposited at other locations. All wastes will either be capped in place or excavated and moved to another portion of the site followed by capping and revegetation. The intent is to reposition the wastes to reduce or eliminate the metals loading characteristics of the current piles or areas. The selected alternative will address 158 acres of mining wastes and 3,500 feet of channel improvements.

Question: A citizen asked if mine shafts will be filled in Baxter Springs and Treece as they were in Galena, Kansas.

Response: There are no plans to fill the mine shafts as was done in Galena. The Galena area did not contain several large scale tailings impoundments for mine waste placement so the large number of mine shafts were thus considered appropriate repositories for the mine wastes. There are fewer shafts and collapse features in the Baxter Springs and Treece areas and a much larger number of tailings impoundments; thus, the selected remedy includes plans to place the wastes in tailings impoundments in the Baxter Springs subsite and then cap the impoundments.

Comment: A citizen expressed concern about water running out of the mine shafts and into surface water streams and creeks. This citizen felt that the shafts needed to be filled to prevent this from happening.

Response: This is a valid concern that has been addressed by the selected alternative. The selected remedy will control mine water discharges from certain mine shafts which were identified for cleanup during the remedial investigation (RI) and feasibility study (FS). As part of the remedial design phase, EPA will also evaluate possible diversions around mine shafts to prevent rain water and surface water runoff from going into the shafts as well as containing any shaft discharges from flowing into surface water bodies.

Question: A citizen asked what was the possibility of the estimated 5.9 million dollar remedy increasing in cost and what was EPA's genuine guess on the cost.

Response: The selected remedy was expected to cost 5.9 million dollars in 1994 and has already increased in cost to approximately 7.1 million dollars as previously discussed. The increase is a result of inflation estimated at 3.5% per year in addition to the inclusion of residential cost assumptions. The original cost estimate was in 1994 dollars and has been updated to reflect 1997 dollars. The original estimate was calculated by Dames and Moore, the engineering firm that conducted the RI/FS. Unforeseen circumstances could potentially increase the existing cost estimate, but there is no current information indicating that this is likely.

Part II: Response to Written Comments

This section provides responses to written comments or questions regarding the proposed plan for the Baxter Springs/Treece subsites of the Cherokee County site.

Comment: EPA received one comment from Gold Fields American Corporation (Gold Fields), in a letter dated 10/14/94 from Terrence Gileo Faye, Esq., to EPA. In that letter, Gold Fields stated that it disagrees with and requests a modification of the statement in the proposed plan, page 4, that the responsible parties "chose not to undertake" the response actions in the Galena subsite of the Cherokee County site.

Response: EPA believes the proposed plan language is accurate. Gold Fields refused to perform the actions required by the unilateral administrative order (UAO) issued on June 10, 1990, EPA Docket No. 90-F-0017. Gold Fields did not comply with this UAO although it offered partial performance. The partial performance activities offered by Gold Fields were inconsistent with the planned response actions and not authorized by EPA. Gold Fields's justification for failing to comply with the UAO was without sufficient cause because Gold Fields's offer was only for partial performance. Therefore, pursuant to Section 122(e)(6) of CERCLA, 42 U.S.C. § 9622(e)(6), EPA requested on August 14, 1990, that Gold Fields cease its unauthorized activities. EPA believes that Gold Fields did have an opportunity to undertake full performance of the response actions and, in fact, declined this opportunity.

Comment: EPA received a letter dated October 4, 1994 from Environmental Management Services Company (EMS) on behalf of ASARCO, Inc., Gold Fields, N.L. Industries, Inc., The Doe Run Company (St. Joe Minerals Corporation), Cyprus Amax Minerals

Company, Inc., and Sun Company, Inc. The following comments were made in the October 4, 1994 letter. EPA responses to the comments are also provided.

Comment: The commentors state that they believe Alternatives 3, 3b, and Modified 5a have similar prescribed actions and the same planned operation and maintenance provisions, and that these alternatives would have nearly equal long-term permanence.

Response: With regard to prescribed actions and long-term permanence, the referenced alternatives are nearly equal only for the Baxter Springs subsite. They are not equal for the Treece subsite since modified alternative 5a proposes engineering actions in the Tar Creek drainage while alternatives 3 and 3b do not. Modified alternative 5a is thus considered to have greater long-term permanence than alternatives 3 and 3b since it includes a greater amount of permanent engineering controls. With regard to operation and maintenance (O&M) provisions, the referenced alternatives are also only approximately equal for the Baxter Springs subsite. Since modified alternative 5a includes greater engineering controls, a greater amount of O&M would also be required.

Comment: The commentors stated that the Ecological Risk Assessment (ERA) determined that there were no exceedances of federal Ambient Water Quality Criteria (AWQC) in the Spring River attributed to the transport of metals from the Baxter Springs subsite.

Response: Irrespective of the status of AWQC exceedances in the Spring River, the streams in the subsite watersheds have designated uses independent of those for the Spring River. Under present site conditions, those uses are not being achieved. In this respect, the remedial action objectives are reasonable for the site. In addition, AWQC are designed to protect 95% of the species 95% of the time, not all species, including protected or sensitive species. Since there are nine State protected species known to occur or to have habitat within the site, the planned response actions are further justified. The commentor implies no exceedances in this subsite. However, Willow Creek has contaminant loading problems that do cause significant metal loads to enter Spring River as evidenced by documented exceedances of AWQC in Spring River. Additionally, the RI/FS estimated that 24,000 pounds of zinc are annually loaded to the Spring River from streams draining the Baxter Springs subsite.

Question: The commentor states that aquatic sampling of Spring Branch did not document any ecological affects attributed to metals in the Spring Branch drainage.

Response: While the field data possibly indicate no acute effects, they are inadequate to determine chronic, sub-lethal effects, which are of greater significance to viability of the on-site populations than the acute effects. In addition, as is stated in Section 8 of the ERA, there are a number of factors that may be masking the toxicity of the metals of concern. These include, but may not be limited to, acclimation of the aquatic species inhabiting on-site ponds and streams, speciation/bioavailability of the metals of concern, and frequency and pattern of occurrence of toxic conditions. While field data for a single fish species may indicate that this single species is seemingly tolerant of adverse conditions, the calculated toxicity quotients (TQs) indicate that non-acclimatized organisms would be adversely affected. Since this condition limits the introduction and establishment of organisms in the affected habitats, ecological structure and function is restricted (i.e., fewer and fewer types or organisms and less resilience in the trophic relationships). Achieving the remedial action objectives and Toxicity Reference Values (TRVs) in the on-site streams will alleviate this situation, even though AWQC may not be achieved in all instances.

Additionally, there were a number of assumptions incorporated into the ERA that would result in a non-conservative (i.e., underestimated) characterization of risk. These all further justify taking actions to reduce ecological risks at the Baxter Springs subsite. For aquatic receptors they include:

°TQs were calculated using LOAELs vs. NOAELS (typically a 10X less stringent value).

°Mean chronic LOAELs were calculated from a range of values rather than taking the most conservative LOAEL value.

°TQs were divided into categories, with values greater than one, but less than five, assumed to reflect individual but not population level effects. For all intents and purposes, concentrations reflecting the potential for adverse effects on individuals were disregarded. The justification for this approach is based on the factors likely influencing the toxicity of metals at the site. These include varying bioavailability due to metal speciation, acclimation, and the ability of aquatic receptors to tolerate infrequent pulses of elevated metals concentrations, as evidenced by site-specific fish data.

°Exposure to sediment was omitted as an exposure pathway. It was assumed that surface water concentrations represented equilibrium conditions with the associated sediments. This may have underestimated exposures to bottom-dwelling or bottom-feeding organisms.

°Dissolved metals concentrations were adjusted using ratios based on stream-specific sampling data (dissolved concentration/total recoverable concentration) rather than assuming 100% availability of total recoverable metals.

For terrestrial receptors they include:

°TQs were calculated using LOAELs vs. NOAELs (typically a 10X less stringent value).

°Mean chronic LOAELs were calculated from a range of values rather than taking the most conservative LOAEL value.

°TQs were divided into categories, with values greater than one, but less than five, assumed to reflect individual but not population level effects.

°For vertebrates, the most likely exposure (MLE) intake estimates were used rather than the reasonable maximum exposure (RME) intake estimates.

Question: The commentor does not believe the proposed remedial action will meet TRVs for Spring Branch with the exception of the lower 2,400 feet, and that a waiver of TRVs will be required.

Response: The TRVs or Preliminary Remediation Goals (PRGs) are not legally enforceable requirements and thus do not require a waiver. The remedial action objectives (RAOs) achieve risk reduction and protection of the environment and may not be waived. Therefore, a "waiver" of TRVs or PRGs is inappropriate. Although EPA believes the remedy will meet TRVs, the selected remedy waives AWQC for acute and chronic protection of aquatic life, because it is not technically practical to achieve the applicable Kansas water quality requirements. EPA believes the RAOs will be met, but AWQC may not be met in the upper reaches of Spring Branch. Note that this response and associated question only pertain to the Baxter Springs subsite.

Question: The commentor requested that EPA reconsider sampling homes within 500 feet of mine waste piles, since the RI tended to show that elevated metals were not present farther than 300 feet from the piles. The commentor believes that the selected remedy may require remediation of residential yards contaminated from lead based paint or other non-mining sources.

Response: EPA acknowledges the results of the RI, but chooses to act more conservatively because the extent of potential residential impacts was not fully characterized during the RI. The amount of residential sampling was somewhat limited in scope and it is therefore not prudent to indicate that there are definitely no impacted residential areas and no need for additional sampling beyond a somewhat arbitrary 300 or 500 feet boundary. This is the reasoning for actually expanding the characterization effort to include the community of Treece, Kansas as well as rural areas of Baxter Springs, Kansas rather than utilizing a strict 300 or 500 feet boundary approach. EPA believes that weathering processes (wind action, infiltration and runoff, mechanical weathering, etc.) are capable of moving and depositing mining wastes a much greater distance than 300 or 500 feet. EPA does agree that the expected number of impacted residences are likely to be few, if any, but feels that additional study, performed during the remedial design (RD) or early remedial action (RA) phases, is necessary in order to be conclusive. With regard to non-mining impacts, while it is apparent that additional sources of lead certainly play a role, it has been well documented that the primary lead impact in the former Tri-State Mining District is from past mining activities.

Question: The commentor questioned the need for a formal "engineered" repository for disposal of residential soil from future home construction. The commentator also felt that soil from commercial development should not be disposed in the repository.

Response: EPA agrees to reconsider the repository issue during the RD phase of the project. If it is determined, as a component of the RD, that there are a sufficient number of existing mine shafts, subsidence areas, or areas of surficial mine wastes located within the entire boundaries of the Cherokee County site, EPA feels that these areas would be more desirable for placement of future excavated residential soils as opposed to a formal engineered repository providing that some type of control would be exercised in these areas.

EPA agrees that the repository, if deemed necessary, would be for soils resulting from future residential development regardless of the size of the development, however, commercial development need not be subject to such institutional controls unless the development presents a risk to human health similar to a residential development, for example, day care centers and recreational facilities that attract young children.

Question: The commentor questioned what type of "monitoring" will be involved with the operation and maintenance for the institutional controls established by the county and requested more detail on the monitoring program.

Response: Monitoring requirements are dependent on the type of institutional controls actually established by the county. Monitoring requirements will be specified once the county has implemented the institutional controls. These are expected to be accomplished during the design phase of the project. EPA anticipates that operation and maintenance monitoring activities would include, at a minimum, the following activities: blood lead sampling and analysis; community and physician health education; lead outreach activities; inspections of engineered structures; and surface water sampling and analysis. It should also be understood that there is some uncertainty regarding the county's implementation and enforcement of institutional controls.

EPA received a letter dated October 14, 1994, from Marcus A. Martin representing NL Industries, Inc. The following summarizes the comments made in the October 14, 1994, letter and the corresponding EPA responses.

Comment: The commentor made the statements that drainage in the Baxter Springs subsite contributes "only a minute percentage" of metals load to the Spring River, the Spring River does not exceed Kansas Aquatic Life Criteria (ACL or federal AWQC), and that the proposed remedy is not cost-effective given the small percentage of metals load.

Response: EPA feels that the selected remedy is cost-effective as it constitutes a much lower cost than several alternatives evaluated in the FS. The selected remedy is actually the least expensive remedy other than the no action alternative and is now estimated at approximately 7.1 million dollars. As a comparison, the most costly alternative was estimated at 93.2 million dollars (1994 total costs). Cost-effectiveness is a modifying criteria to be applied as part of a comparison of overall effectiveness and cost, see the NCP, 40 C.F.R. §300.430(f)(1)(ii)(D), which states that a "remedy shall be cost-effective if its costs are proportional to its overall effectiveness". EPA believes the proposed remedy is cost-effective and meets the standards in CERCLA and the NCP.

Information and analytical data from the Kansas Department of Health and Environment (KDHE) indicates that the Spring River does exceed alternate concentration limits (ACLs) for cadmium, lead, and zinc. The selected remedy is a single component which addresses one operable unit of the overall Cherokee County site. EPA's goal for the site as a whole includes remediation of significant sources of metals loading to the Spring River. The approach at Baxter Springs will assist in the achievement of that goal. EPA also believes the an annual zinc loading of 24,000 pounds, as estimated in the RI/FS, is not a minute amount of metals loading to the Spring River.

Comment: The commentor states that metals loading from selected piles do not adversely impact biota in Spring Branch or Willow Creek and the effects are overestimated. The commentor also states that biota in Spring Branch are healthy and reproducing normally, and that the TRVs were not accurately calculated.

Response: The calculated TRVs, and exposure point concentrations (EPCs), for Spring Branch and Willow Creek were based on EPA approved methods. The RI/FS and associated analytical work identified piles or mine waste areas contributing significant metal loads to streams. EPA believes there is a large body of evidence that indicates environmental harm is resulting from this site. The zinc loading to Spring River from Spring Branch and Willow Creek was estimated at 24,000 pounds annually in the RI/FS reports which were prepared by PRPs. The zinc loading to Tar Creek was estimated at 220,000 pounds per year at the Treece subsite while the total zinc load, inclusive of the major downstream Oklahoma portion, was estimated at 2.8 million pounds per year. Tar Creek is classified as a no beneficial use water body in Oklahoma, technically impracticable to repair or remediate the manmade degradation. Thus, it is clearly obvious that past mining practices have definitely impacted surface water bodies in the Kansas and Oklahoma portions of the Tri-State Mining District. Additionally, information from nearby sites in Missouri indicates a similar situation.

A prior response provides information on several factors that are masking the toxicity of the metals of concern. The ERA also contained several assumptions which would significantly underestimate the degree of risk.

Comment: The commentor disagrees with the calculation of TQs for fish and mink, and states that mink were not collected or sampled from the site to assess the effect on them from metals contamination.

Response: EPA believes that the TQs were properly calculated. TQs are based on the TRVs in comparison to site specific values. Tables 8-4 and 8-6 of the ERA summarize the TQs for aquatic vertebrates and aquatic invertebrates, respectively, based on the concentration of each dissolved fraction metal occurring in each specific drainage within each subsite. Moreover, the percent bioavailability (i.e., dissolved concentration/total recoverable concentration) of each metal was calculated based on site-specific data.

Site-specific TQs were calculated using median chronic lowest observed adverse effects levels (LOAELs) adjusted based on uncertainty factors associated with extrapolations between test species and species of interest, duration of test differences, and variations in measured effects (e.g., no observed adverse effect level vs. lowest observed adverse effect level, vs. LD_{50}, etc.). More recent risk assessments have incorporated adjustments to toxicity reference values based on allometric relationships between the mean weight of the test organism and that of the organism of interest. EPA has compared the adjusted LOAELs used in this risk assessment with values calculated using more recent toxicity test data and the allometric equations and finds that, while not identical, the LOAELs used are acceptable.

Section 4.3 of the ERA states that, when identifying chemicals of concern (COCs), the risk assessors did combine data for the upstream sampling locations of Tar Creek and Willow Creek, owing to a lack of significant difference in the data as measured by a one-tailed t-test. Furthermore, the risk assessors combined the downstream sampling station data within each drainage, but not between drainages, for comparison to the upstream sampling stations. As stated above, however, TQs were calculated on a stream-specific basis and are properly calculated.

With respect to the mink, the comment does not recognize the concept of assessment endpoints in ecological risk assessments. The mink was chosen to represent those upper trophic level organisms at the site that would consume both aquatic and terrestrial organisms. The mink represents a functional element of the ecosystem, not just the mink itself. While the concentration of contaminants in prey organisms may be influenced by the size of their home range, habitat, or even patterns of behavior, the home range and feeding area of the predator organism determines the validity of consolidating exposures related to food sources. In this instance, the typical home range of a mink comprises well over 50% of the area of the larger of the two subsites, and an even larger percentage of the area of the smaller subsite. In addition, the ingestion scenario used in the ERA assumed 50% mice and 50% fish in the diet of the mink. Information in EPA's *Wildlife Exposures Handbook* indicates that during certain portions of the year amphibians may make up a significant portion of the diet of the mink. Amphibians may have body burdens of metals equal to or greater than those evidenced by on-site mice and fish, although these prey organisms were omitted from the ingestion calculations. Consequently, the consolidation of data for mice and fish between subsites is justified and conservative.

Comment: The commentor suggests that the selected remedy would destroy critical habitat for Kansas threatened and endangered (T&E) species.

Response: EPA has coordinated with the Kansas Department of Wildlife and Parks (KDWP) and determined that certain species are listed as Kansas T&E species due to the range of the species. In other words, the area of the Cherokee County site is within the current range of these species although the species are likely more common in other parts of the state. EPA has every intent to coordinate all remedial actions with KDWP to ensure habitat is not disturbed if, in fact, a species is present at a particular part of the site.

Comment: The commentor suggests that EPA has not considered recent changes or reductions in metals loading to streams at the site resulting from cessation of activities at the Bingham Sand and Gravel operation located at the head of Willow Branch or the remediation of the Galena subsite.

Response: EPA has assessed the changes cited by the commentor. With respect to Willow Branch, even though the chat washing operation in Bingham's pond has ceased, the outwash sediments in the branch require removal in order to eliminate the source. EPA acknowledges the achievement of water quality improvement at the

Cherokee County, Galena subsite by the past remediation of wastes. However, as mentioned above, there are other significant sources of metals loading that require remediation in order to improve water quality in the Spring River basin. These sources include the Baxter Spring subsite as well as the Jasper County, Missouri Superfund site.

Comment: The commentor suggests that the risks posed to the Spring River by the Baxter Springs subsite are no greater than the risks posed to the Neosho River by the Treece subsite, and since EPA is not proposing remedial action (non-residential) for the Treece subsite, the Baxter Springs subsite should also not be remediated with respect to non-residential actions. Additionally, the commentor states that since EPA decided that remediation (non-residential) in Treece would not be cost-effective, and that the cost-per-pound of zinc reduction in Baxter Springs is higher than for Treece, the Baxter Springs subsite should likewise not be remediated.

Response: EPA disagrees with the commentor's logic of deciding or recommending not to take action at the Baxter Springs subsite simply because actions are not recommended at the Treece subsite. Again, the actions discussed in this comment and response are the engineering controls for mining wastes impacting surface water bodies and ecological receptors as opposed to the potential residential components of the remedy. There are important distinctions between Tar Creek which drains the Treece subsite and Spring Branch/Willow Creek which drain the Baxter Springs subsite. A significant factor in the selection of differing actions for the two streams are the substantially different downstream surface water quality and uses of each stream in addition to consistency with past actions implemented by EPA Region VI and the state of Oklahoma for the Tar Creek drainage basin.

Tar Creek briefly flows through Kansas prior to entering Oklahoma and subsequently travels a much greater distance in Oklahoma prior to discharging to the Neosho River, also in Oklahoma. The major impacts to Tar Creek are from mining wastes in Oklahoma since the majority of the stream flow is in Oklahoma and there are substantial historic mining areas in Oklahoma. The Oklahoma portion of Tar Creek is classified as an irreparable surface water body which has been degraded by manmade actions.

The state of Oklahoma and EPA Region VI have determined that it is impracticable to attempt to remediate Tar Creek, thus the relatively small portion of the creek which flows through Kansas would similarly be technically impracticable to remediate since any environmental gain would be small when considering the size of the entire drainage basin and the fact that the creek would immediately become re-contaminated as it entered Oklahoma. Conversely, the end point for Spring Branch and Willow Creek (draining the Baxter Springs subsite) is the Spring River which is a valuable surface water resource used for recreation and swimming. This resource will be protected by the selected remedy which very appropriately specifies differing actions for the different streams draining the two subsites. Moreover, Spring Branch and Willow Creek have designated uses independent of Spring River. Under present site conditions, those uses are not being achieved. In this respect, the selected remedy is appropriate for the Baxter Springs subsite because it will improve water quality in these streams.

The commentor's focus on cost-effectiveness is based on a comparison of the cost-per-pound of zinc reduction in Tar Creek ~~and fails to fully consider the broad cost-effectiveness of a Tar~~ Creek remedy, which must be made in the context of the whole stream system. EPA considered the overall cost of cleanup for all of Tar Creek in Kansas at approximately 65.5 million dollars (an approximate 93.2 million dollar total remedy) as estimated in 1994 dollars. Comparing this cost with the amount of expected zinc reduction in Tar Creek at the Neosho River does not appear to be cost-effective, especially considering that no actions are being implemented in Oklahoma due to the severely degraded and irreparable nature of the stream. In addition, the cleanup of Tar Creek is not cost-effective in Kansas when considered in full context that after crossing the Kansas/Oklahoma state line, the stream is immediately re-contaminated. Conversely, the remediation of the Baxter subsite streams is deemed cost effective since valuable water resources will be improved; Spring Branch, Willow Creek, and Spring River. The zinc loading to Spring River from Spring Branch and Willow Creek (draining the Baxter Springs subsite) was estimated at 24,000 pounds per year in the RI/FS reports. The surface water quality remediation costs for the selected remedy at the Baxter Springs subsite are estimated at approximately 3.2 million dollars (1997 estimate). EPA thus considers the approximate 7.1 million dollar remedy (total costs in 1997 dollars) to be extremely cost-effective.

Additionally, EPA must again point out, as at the Proposed Plan stage, that the Agency is not proposing any remedial action for mining wastes impacting surface water bodies in the Treece subsite at this time. Should EPA Region VI, EPA's lead office for work in Oklahoma, take additional actions in Tar Creek to improve water quality or if the states of Kansas or Oklahoma recommend improving the water quality in Tar Creek, EPA Region VII will reconsider a new proposal for remedial action in the Treece subsite in accordance with the requirements of the NCP. This remedy will also be reassessed on a five-year basis and may require modification or additional effort if deemed necessary.

Comment: The commentor speculates that the selected remedy will not achieve the remedial action objectives for Spring Branch surface water and that EPA should waive chemical-specific ARARs for the surface waters of the Baxter Springs subsite.

Response: EPA believes that the remedy will meet the remedial action objectives. If it is determined during subsequent five-year reviews of the selected remedy that the objectives are not being met, EPA may reassess the remedial action and require additional actions be performed to further reduce metals loading to the streams in order to then meet the remedial action objectives.

EPA agrees that chemical-specific ARARS for surface waters of the Baxter Springs subsite should be waived under the selected remedy. The ARARs that will not be met by the selected remedy are waived in the Decision Summary portion of the ROD. EPA also re-emphasizes that remedial action objectives are not identical to chemical-specific ARARs. The remedial action objectives for surface water cleanup include the TRVs, which were approved by EPA. However, TRVs are not ARARs.

ATTACHMENT 2 - IEUBK MODEL DATA AND INFORMATION

Attachment #2 - Baxter Springs/Treece ROD

This attachment contains additional supporting information pertaining to the integrated exposure uptake biokinetic model (IEUBK) and the adult lead model. As referenced in the Record of Decision for operable unit #03/04 of the Cherokee County, Kansas site, the residential action levels are risk management values utilized for the entire Tri-State Mining District sites in EPA Region VII. The Cherokee County, Kansas and Jasper County, Missouri sites are contiguous to one another and are predominantly separated based on the Kansas/Missouri state line. The area is sufficiently similar and was only divided into two separate sites predominantly based on the fact that the area encompasses portions of two states; thus, EPA has extrapolated or utilized the modeling results for the Missouri portion to also apply to the contiguous Kansas portion of the historic mining district. In an effort to be consistent in the close geographic regions of two states, EPA has chosen to use the same residential action levels for the two Superfund sites. Additionally, these two sites are divided into several operable units. EPA feels that it would be extremely cumbersome and inconsistent to utilize differing residential cleanup criteria for all of the operable units which encompass both contiguous sites.

The IEUBK modeling for the Jasper County, Missouri site was performed by the Missouri Department of Health and is attached. The attachment specifies the model values that were utilized for the various runs and the predicted blood level results for varying scenarios. This modeling formed the basis for the selection of cleanup levels for all Tri-State Mining District sites within Region VII.

The adult lead model was run for OU-3/4 for informational purposes only. The non-residential actions prescribed by the ROD are based on ecological risks while the residential actions are based on IEUBK modeling and consistency approaches. The adult lead attachment is provided simply for background or additional information.

MISSOURI DEPARTMENT OF
HEALTH

Mel Carnahan
Governor

Coleen Kivlahan, M.D., M.S.P.H.
Director

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June 1, 1995

RECEIVED
JUN 05 1995
OFFICE OF THE DIRECTOR
WSTM DIVISION

Mr. Mark Doolan
Remedial Project Manager
U. S. Environmental Protection Agency
726 Minnesota Ave.
Kansas City, KS 66101

Dear Mr. Doolan,

Enclosed is a draft Technical Memorandum for the Jasper County Site. The Memorandum provides a brief risk analysis of several clean-up options which are being considered for the Jasper County site.

If you have any comments or questions on the document or we can be of further assistance, please feel free to call me at (314) 751-6111.

Sincerely,

Cherri Baysinger-Daniel
Environmental Specialist
Bureau of Environmental Epidemiology

CBD:egd

Attachment
cc: Dave Mosby

DRAFT

Technical Memorandum

Risk Analysis of Clean-Up Options for the Jasper County Site, Jasper County, MO

The Jasper County Site is a former lead and zinc mining, milling and smelting area in southwest Missouri. Soils, streams and groundwater at the site are contaminated with heavy metals, primarily cadmium, lead and zinc. Very high concentrations of lead (>5,000 mg/kg) have been found in residential yards in some areas of the site, primarily in the vicinity of the former Eagle Picher Smelter.

A lead and cadmium exposure study was conducted by the Missouri Department of Health to determine if there was a relationship between exposure to lead and cadmium at the site and elevated blood lead and urine cadmium levels. A study group was randomly chosen from people living in the vicinity of the Jasper County Site. A similar control group was randomly chosen from an area unaffected by mining, milling and smelting of lead and zinc. Conclusions of the study indicated blood lead levels were significantly greater in the study area than in the control area and that environmental exposure to lead in soil was the most important factor influencing blood lead levels (MDOH 1995).

Blood lead levels are a measure of an individual's level of exposure to lead. Blood lead levels as low as 10 ug/dL have been associated with subtle adverse health effects such as decreased intelligence, impaired neurobehavioral development and decreased hearing acuity. The severity of effects increases as blood lead levels increase. At extremely high blood lead levels (>80 ug/dL), coma, convulsions and death have occurred (CDC 1991).

The Integrated Exposure Uptake Biokinetic Model (IEUBK) is a computer model created by EPA to estimate a plausible distribution of blood lead levels resulting from environmental exposure to lead. The model was developed using environmental and biological data from a lead mining and smelting Superfund site. The model combines lead concentrations in air, drinking water, diet, soil and household dust with behavior and biokinetic variables to predict blood lead levels in children aged 0-6 years. Default values are provided for each variable used in the model. The model allows and encourages use of site-specific values for most variables.

The IEUBK was used to evaluate several options currently under consideration for the remedial and removal activities at the Jasper County Site. The proposed options are:

- Removal of soil from all houses with soil lead over 5,000 mg/kg
- Removal of soil from all houses with soil lead over 4,000 mg/kg
- Removal of soil from all houses with soil lead over 3,000 mg/kg

- Removal of soil from all houses with soil lead over 2,500 mg/kg
- Removal of soil from houses where the block soil lead value averages 2,000 mg/kg
- Removal of soil from all houses with soil lead over 1,000 mg/kg.
- Removal of soil from all houses with soil lead over 800 mg/kg.

All options were evaluated using the specified soil lead concentration and site-specific values for other variables. Each option was evaluated with and without a backyard gardening scenario. Site-specific lead concentrations in air, drinking water and garden produce were determined during the Jasper County Remedial Investigation (Dames and Moore 1995). A table summarizing these values is presented in Appendix I. Paired soil lead and household dust lead samples were collected during the Lead and Cadmium Exposure study (MDOH 1995). The paired samples were examined to determine if a relationship existed between soil and dust lead concentrations. The following equation describes that relationship:

$$\ln(\text{dust Pb})=0.56[\ln(\text{soil Pb})]+2.78$$
$$(n=125,\ r^2=0.36,\ p<0.01)$$

This regression was used to predict the lead-in-dust concentration for each soil level proposed.

For each option, the estimated mean blood lead level, the percentage of the population predicted to exceed 15 ug/dL and the percentage of the population predicted to exceed 10 ug/dL are presented in Table 1.

Table 1
Summary of Risk Analysis for
Proposed Soil Levels at the Jasper County Site

	With Backyard Gardens			Without Backyard Gardens		
Soil/Dust Lead (mg/kg)	**Mean Predicted Blood Lead (ug/dL)**	**Percent Predicted to Exceed 15 ug/dL**	**Percent Predicted to Exceed 10 ug/dL**	**Mean Predicted Blood Lead (ug/dL)**	**Percent Predicted to Exceed 15 ug/dL**	**Percent Predicted to Exceed 10 ug/dL**
5,000/1,900	21.0	72.73	92.6	19.3	66.92	90.67
4,000/1,677	19.3	66.92	90.67	17.5	61.13	86.23
3,000/1,427	17.3	58.29	86.23	15.3	50.13	78.40
2,500/1,289	16.1	52.78	81.13	14.0	42.68	72.73
2,000/1,137	14.9	47.56	78.4	12.7	34.02	66.92
1,000/772	11.7	28.52	61.13	9.2	13.64	40.37
800/681	10.9	23.80	55.50	8.3	9.36	32.10

For the purpose of comparison, EPA's soil lead guidance states that an unacceptable health risk is presented when more than 5% of a population's blood lead level is predicted to exceed 10 ug/dL (EPA 1994).

None of these options alone meet the criteria set forth in the current soil lead guidance. There are additional intervention measures which could be taken to further reduce exposure to lead. Potential measures may include providing health education and HEPA vacuum cleaners, which may substantially reduce the lead load in household dust. To evaluate this alternative, the IEUBK was run for each of the proposed options with the dust concentration set at the default of 200 mg/kg. Results of these model runs are presented in Table 2.

Table 2
Summary of Risk Analysis for Proposed Soil Levels with Additional Intervention at the Jasper County Site

Soil/Dust Lead (mg/kg)	With Backyard Gardens			Without Backyard Gardens		
	Mean Predicted Blood Lead (ug/dL)	Percent Predicted to Exceed 15 ug/dL	Percent Predicted to Exceed 10 ug/dL	Mean Predicted Blood Lead (ug/dL)	Percent Predicted to Exceed 15 ug/dL	Percent Predicted to Exceed 10 ug/dL
5,000/200	13.3	36.13	69.83	10.9	23.80	55.50
4,000/200	12.1	30.26	64.01	9.6	16.45	45.07
3,000/200	10.8	22.39	52.78	8.2	9.36	32.10
2,500/200	10.2	18.62	47.56	7.5	6.42	25.29
2,000/200	9.5	15.45	42.68	6.7	3.90	18.62
1,000/200	8.0	8.79	30.26	5.0	0.92	6.84
800/200	7.7	7.28	26.86	4.7	0.61	5.00

In conclusion, at the lead concentrations currently being considered, it does not appear that soil removal alone will be a sufficient remedy. If one of the proposed levels is selected as the clean-up level for Jasper County, additional measures to reduce lead exposure, such as providing clean fill for garden plots, providing HEPA vacuum cleaners and continued blood lead monitoring and health education may be necessary remedial activities for the Jasper County site.

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Appendix I
Summary of Site-specific Input Values Used for the IEUBK
Jasper County Superfund Site, Jasper County, MO

Table A-1
Summary of Site-specific Inputs for the IEUBK

Variable	Default Value	Site-specific Value	Value Used
Air			
Mean concentration of Pb in air	0.1 ug/m^3	0.07 ug/m^3	0.07 ug/m^3
Vary air concentration by year	No	No	No
Indoor air Pb concentration as a percent of outdoor air concentration	30%	30%	30%
Drinking Water			
Mean concentration of Pb in water	4.0 ug/L	3.0 ug/L	3.0 ug/L
Diet			
Alternate diet values	No	Table 2	Table 2
Percent of diet which is fruit/leafy vegetables	N/A	2.5%	2.5%
Percent of diet which is root vegetables	N/A	2.5%	2.5%
Percent of diet which is local fish	N/A	0.6%	0.6%
Percent of diet which is local beef	N/A	2.6%	2.6%
Soil/Dust			
Mean concentration of Pb in soil	200 mg/kg	Varies	Varies
Indoor dust Pb concentration	200 mg/kg	Varies	Varies
Soil/dust weighting factor	45%	17.5%	17.5%

Table A-2
Concentrations of Lead in Various Diet Components

Media	Lead Concentration (mg/kg)
Fruits/leafy vegetables	0.62
Root vegetables	6.2
Fish fillets	0.08
Beef/game meat	0.05

Values determined during the Remedial Investigation for the site (Dames and Moore, 1994).

Adult Lead Model Assumptions
Baxter Springs and Treece Subsites
Cherokee County, Kansas Superfund Site

- 95th Percentile Blood Lead in fetus ($PbB_{fetal,0.95}$): The agency guideline for protection of children using the IEUBK is 10 µg/dL. The point value of 10 µg/dL was used in this assessment.

- Mean ratio of fetal to maternal Blood Lead (R_f): A point value of 0.9 has been suggested based on Goyer (1990) and Graziano et al. (1990). This point value was selected in the California Gulch evaluation and, for consistency, was used in this assessment.

- Individual geometric standard deviation (GSD_i): A range of values from 1.6 (IEUBK) to 2.6 (National Health and Nutrition Examination Surveys, NHANES III) have been suggested for GSD_i. The NHANES survey included exposures to a wide range of lead sources. The population expected to be exposed to the Federal Tailings dam is relatively homogenous, thus a GSDi of 1.8 was used in this assessment.

- Baseline blood lead value ($PbB_{adult,0}$): The national estimates from NHANES range from 1.7 to 2.2 µg/dL, depending on the racial and ethnic composition of the target population. A value of 2.0 µg/dL was used in this assessment because it represented an approximate central point of the range of possible values.

- Biokinetic slope factor (BKSF, ug/dL per ug/day): Based on the data presented in Pocock et al. (1983) and Sherlock et al. (1984), a point value of 0.4 has been suggested. That value was used in this assessment.

- Soil ingestion rate (IR_s, g/day): Occupational soil ingestion rates may vary from 0.05 g/day (office worker) to 0.48 g/day (gardener/landscaper), depending upon the occupation. Persons working around the site are expected to have more contact with soils than an office worker, but less than gardeners/landscapers, thus a soil ingestion rate of 0.1 g/day was used in this assessment.

- Soil Exposure frequency (EFs) (days/yr): Agency guidance suggests a default value of 250 days per year. Because persons working on the site are not expected to be exposed to the dam area on a daily basis, an exposure frequency of 100 days/year was used in this analysis.

- Absolute Gastrointestinal Absorption fraction (AF, unitless): A site specific estimate of 0.15 was chosen for use in this analysis.

Results - Screening Level for Lead Program v1.00

95th Percentile PbB in fetus (PbB95 fetal) (ug/dL)	: 10
Mean ratio of fetal to maternal PbB (R)	: 0.9
Individual geometric standard deviation (GSDi)	: 1.8
Baseline blood lead value (PbB0) (ug/dL)	: 2
Biokinetic slope factor (BKSF) (ug/dL per ug/day)	: 0.4
Soil ingestion rate (IRs) (g/day)	: 0.05
Dust ingestion rate (IRd) (g/day)	: 0.05
Ratio of concentration in dust to that in soil (Ksd)	: 1
Soil Exposure frequency (EFs) (days/yr)	: 100
Dust Exposure frequency (EFd) (days/yr)	: 100
Absolute absorption fraction of lead in soil (AFs)	: 0.15
Absolute absorption fraction of lead in dust (AFd)	: 0.15

Screening Level for Lead (PRG) (ug/g): 1354

Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Preface

This report includes a fact sheet, *Technical Review Workgroup for Lead (TRW) Recommendations for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* along with an Appendix, *Equations and Rationale for Default Values Assigned to Parameters in the Slope Factor Approach and Exposure Model for Assessing Risk Associated with Adult Exposures to Lead in Soil*, which discusses in greater detail the equations and parameters used in the methodology.

U.S. Environmental Protection Agency

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1. INTRODUCTION

This report describes a methodology for assessing risks associated with non-residential adult exposures to lead in soil. The methodology focuses on estimating fetal blood lead concentration in women exposed to lead contaminated soils. This approach also provides tools that can be used for evaluating risks of elevated blood lead concentrations among exposed adults. The methodology is the product of extensive evaluations by the Technical Review Workgroup for Lead (TRW) which began considering methodologies to evaluate nonresidential adult exposure in 1994 (Balbus-Kornfeld, 1994; U.S. EPA, 1994a). In 1995, the TRW reviewed a methodology developed by EPA Region 8 for deriving risk-based remediation goals (RBRGs) for nonresidential soil at the California Gulch NPL site (U.S. EPA, 1995). A TRW committee on adult lead risk assessment was formed in January, 1996 to further develop the ideas and information gathered as part of these previous efforts into a generic methodology that could be adapted for use in site-specific assessments.

This report provides technical recommendations of the TRW for the assessment of adult lead risks using this methodology. An overriding objective in the development of this methodology was the immediate need for a scientifically defensible approach for assessing adult lead risks associated with nonresidential exposure scenarios. The TRW recognizes that other adult lead models may provide useful information. In particular, models providing more detailed representations of lead kinetics may be useful in supporting more detailed predictions about the time course of blood lead concentrations among individuals who receive brief acute exposures to lead or whose exposures otherwise change markedly with time. The methodology presented here uses a simplified representation of lead biokinetics to predict quasi-steady state blood lead concentrations among adults who have relatively steady patterns of site exposures (as described in this report). The TRW believes that this approach will prove useful for assessing most sites where places of employment are (or will be) situated on lead contaminated soils. This information is expected to promote consistency in assessments of adult lead risks. The methodology described in this report is an interim approach that is recommended for use pending further development and evaluation of integrated exposure biokinetic models for adults. The TRW is undertaking review of other models and will provide reviews on other approaches as appropriate. The Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children (U.S. EPA, 1994b,c) is the recommended approach for assessing residential lead risks.

The recommended approach for assessing nonresidential adult risks utilizes a methodology to relate soil lead intake to blood lead concentrations in women of child-bearing age. It is conceptually similar to a slope factor approach for deriving RBRGs that had been proposed by Bowers et al. (1994) and which was adapted for use at the California Gulch NPL site in Region 8 (U.S. EPA, 1995). This report describes the basic algorithms that are used in the methodology and provides a set of default parameter values that can be used in cases where high quality data are not available to support site-specific estimates. The rationale for each parameter default value is provided in the Appendix.

2. OVERVIEW OF THE APPROACH

The methodology described in this report relates soil lead concentrations to blood lead concentrations in the exposed population according to the algorithms described below. Note that the algorithms may consist of variables that include superscripts and/or subscripts. The convention adopted in this report is to use superscripts as exponents (i.e., a mathematical operation), whereas subscripts represent key words that provide additional information to distinguish between similar variables. The basis for the calculation of the blood lead concentration in women of child-bearing age is the algorithm given by Equation 1:

$$PbB_{adult,central} = PbB_{adult,0} + \frac{PbS \cdot BKSF \cdot IR_S \cdot AF_S \cdot EF_S}{AT} \qquad \text{(Equation 1)}$$

where:

$PbB_{adult,\,central}$ = Central estimate of blood lead concentrations (µg/dL) in adults (i.e., women of child-bearing age) that have site exposures to soil lead at concentration, PbS.

$PbB_{adult,\,0}$ = Typical blood lead concentration (µg/dL) in adults (i.e., women of child-bearing age) in the absence of exposures to the site that is being assessed.

PbS = Soil lead concentration (µg/g) (appropriate average concentration for individual).

BKSF = Biokinetic slope factor relating (quasi-steady state) increase in typical adult blood lead concentration to average daily lead uptake (µg/dL blood lead increase per µg/day lead uptake).

IR_S = Intake rate of soil, including both outdoor soil and indoor soil-derived dust (g/day).

AF_S = Absolute gastrointestinal absorption fraction for ingested lead in soil and lead in dust derived from soil (dimensionless).

EF_S = Exposure frequency for contact with assessed soils and/or dust derived in part from these soils (days of exposure during the averaging period); may be taken as days per year for continuing, long term exposure.

AT = Averaging time; the total period during which soil contact may occur; 365 days/year for continuing long term exposures.

The basis for the RBRG calculation is the relationship between the soil lead concentration and the blood lead concentration in the developing fetus of adult women that have site exposures. As a health-based goal, EPA has sought to limit the risk to young children of having elevated blood lead concentrations. Current Office of Solid Waste and Emergency Response (OSWER) guidance calls for the establishment of cleanup goals to limit childhood risk of exceeding 10 μg/dL to 5% (U.S. EPA, 1994a). Equation 2 describes the estimated relationship between the blood lead concentration in adult women and the corresponding 95th percentile fetal blood lead concentration ($PbB_{fetal,\,0.95}$), assuming that $PbB_{adult,\,central}$ reflects the geometric mean of a lognormal distribution of blood lead concentrations in women of child-bearing age. If a similar 95th percentile goal is applied to the protection of fetuses carried by women who experience nonresidential exposures, Equation 2 can be rearranged to reflect a risk-based goal for the central estimate of blood lead concentrations in adult women using Equation 3:

$$PbB_{fetal,0.95} = PbB_{adult,central} \cdot GSD_{i,adult}^{1.645} \cdot R_{fetal/maternal} \qquad \text{(Equation 2)}$$

$$PbB_{adult,central,goal} = \frac{PbB_{fetal,0.95,goal}}{GSD_{i,adult}^{1.645} \cdot R_{fetal/maternal}} \qquad \text{(Equation 3)}$$

where:

$PbB_{adult,\,central,\,goal}$ = Goal for central estimate of blood lead concentration (μg/dL) in adults (i.e., women of child-bearing age) that have site exposures. The goal is intended to ensure that $PbB_{fetal,\,0.95,\,goal}$ does not exceed 10 μg/dL.

$PbB_{fetal,\,0.95,\,goal}$ = Goal for the 95th percentile blood lead concentration (μg/dL) among fetuses born to women having exposures to the specified site soil concentration. This is interpreted to mean that there is a 95% likelihood that a fetus, in a woman who experiences such exposures, would have a blood lead concentration no greater than $PbB_{fetal,\,0.95,\,goal}$ (i.e., the likelihood of a blood lead concentration greater than 10 μg/dL would be less than 5%,for the approach described in this report).

$GSD_{i,\,adult}$ = Estimated value of the individual geometric standard deviation (dimensionless); the GSD among adults (i.e., women of child-bearing age) that have exposures to similar on-site lead concentrations, but that have non-uniform response (intake, biokinetics) to site lead and non-uniform off-site lead exposures. The exponent, 1.645, is the value of the standard normal deviate used to calculate the 95th percentile from a lognormal distribution of blood lead concentration.

$R_{fetal/maternal}$ = Constant of proportionality between fetal blood lead concentration at birth and maternal blood lead concentration (dimensionless).

The soil lead concentration associated with a given exposure scenario and PbB $_{adult,central,goal}$ can be calculated by rearranging Equation 1 and substituting PbB $_{adult,central,goal}$ for $PbB_{adult,central}$:

$$RBRG = PbS = \frac{(PbB_{adult,central,goal} - PbB_{adult,0}) \cdot AT}{(BKSF \cdot IR_S \cdot AF_S \cdot EF_S)} \qquad \text{(Equation 4)}$$

It is this form of the algorithm that can be used to calculate a RBRG where the RBRG represents the soil lead concentration (PbS) that would be expected to result in a specified adult blood lead concentration (PbB $_{adult,central,goal}$) and corresponding 95th percentile fetal blood lead concentration (PbB $_{fetal,0.95,goal}$).

Equations 1-4 are based on the following assumptions:

1. Blood lead concentrations for exposed adults can be estimated as the sum of an expected starting blood lead concentration in the absence of site exposure ($PbB_{adult,0}$) and an expected site-related increase.

2. The site-related increase in blood lead concentrations can be estimated using a linear biokinetic slope factor (BKSF) which is multiplied by the estimated lead uptake.

3. Lead uptake can be related to soil lead levels using the estimated soil lead concentration (PbS), the overall rate of daily soil ingestion (IR_S), and the estimated fractional absorption of ingested lead (AF_S). The term "soil" is used throughout this document to refer to that portion of the soil to which adults are most likely to be exposed. In most cases, exposure is assumed to be predominantly to the top layers of the soil which gives rise to transportable soil-derived dust. Exposure to soil-derived dust occurs both in outdoor and indoor environments, the latter occurring where soil-derived dust has been transported indoors. Other types of dust, in addition to soil-derived dust, can contribute to adult lead exposure and may even predominate in the occupational setting; these include dust generated from manufacturing processes (e.g., grinding, milling, packaging of lead-containing material), road dust, pavement dust, and paint dust. This methodology, as represented in Equations 1 and 4, does not specifically account for site exposure to dusts that are not derived from soil. However, the methodology can be modified to include separate variables that represent exposure to lead in various types of dust. This approach is discussed in greater detail in the Appendix.

4. As noted above, exposure to lead in soil may occur by ingesting soil-derived dust in the outdoor and/or indoor environments. The default value recommended for IR_S (0.05 g/day) is intended for occupational exposures that occur predominantly indoors. More intensive soil contact would be expected for predominantly outdoor activities such as construction, excavation, yard work, and gardening.

5. A lognormal model can be used to estimate the inter-individual variability in blood lead concentrations (i.e., the distribution of blood lead concentrations in a population of individuals who contact similar environmental lead levels).

6. Expected fetal blood lead concentrations are proportional to maternal blood lead concentrations.

The primary basis for using Equation 4 to calculate a RBRG is that fetuses and neonates are a highly sensitive population with respect to the adverse effects of lead on development and that 10 µg/dL is considered to be a blood lead level of concern from the standpoint of protecting the health of sensitive populations (U.S. EPA, 1986, 1990; NRC, 1993). Therefore, risk to the fetus can be estimated from the probability distribution of fetal blood lead concentrations (i.e., the probability of exceeding 10 µg/dL), as has been the approach taken for estimating risks to children (U.S. EPA, 1994a,c). Equation 4 can be used to estimate the soil lead concentration at which the probability of blood lead concentrations exceeding a given value (e.g., 10 µg/dL) in fetuses of women exposed to environmental lead is no greater than a specified value (e.g., 0.05).

The methodology can be modified to accommodate different assumptions or to estimate RBRGs for different risk categories. For example, a RBRG could be estimated for risks to adults (e.g., hypertension) by substituting an appropriate adult blood lead concentration benchmark. Similarly, other exposure scenarios can be incorporated into the assessment. Alternative methods for estimating soil lead risk by partitioning soil into outdoor soil and indoor dust components are discussed in the Appendix.

Recommended default values for each of the parameters in Equations 1 - 4 are presented in Table 1. These defaults should not be casually replaced with other values unless the alternatives are supported by high quality site-specific data to which appropriate statistical analyses have been applied and that have undergone thorough scientific review. Examples of the output from the methodology are presented in Figures 1 and 2, which show plots of the calculated $PbB_{fetal,\,0.95}$ as a function of PbS when different combinations of default parameter values are used. The rationale for each default value listed in Table 1 is summarized in the Appendix.

Table 1. Summary of Default Parameter Values for the Risk Estimation Algorithm (Equations 1 - 4)

Parameter	Unit	Value	Comment
$PbB_{fetal, 0.95, goal}$	µg/dL	10	For estimating RBRGs based on risk to the developing fetus.
$GSD_{i, adult}$	--	1.8 2.1	Value of 1.8 is recommended for a homogeneous population while 2.1 is recommended for a more heterogeneous population.
$R_{fetal/maternal}$	--	0.9	Based on Goyer (1990) and Graziano et al. (1990).
$PbB_{adult,0}$	µg/dL	1.7-2.2	Plausible range based on NHANES III phase 1 for Mexican American and non-Hispanic black, and white women of child bearing age (Brody et al. 1994). Point estimate should be selected based on site-specific demographics.
BKSF	µg/dL per µg/day	0.4	Based on analysis of Pocock et al. (1983) and Sherlock et al. (1984) data.
IR_S	g/day	0.05	Predominantly occupational exposures to indoor soil-derived dust rather than outdoor soil; (0.05 g/day = 50 mg/day).
EF_S	day/yr	219	Based on U.S. EPA (1993) guidance for average time spent at work by both full-time and part-time workers (see Appendix for recommendations on minimum exposure frequency and duration).
AF_S	--	0.12	Based on an absorption factor for soluble lead of 0.20 and a relative bioavailability of 0.6 (soil/soluble).

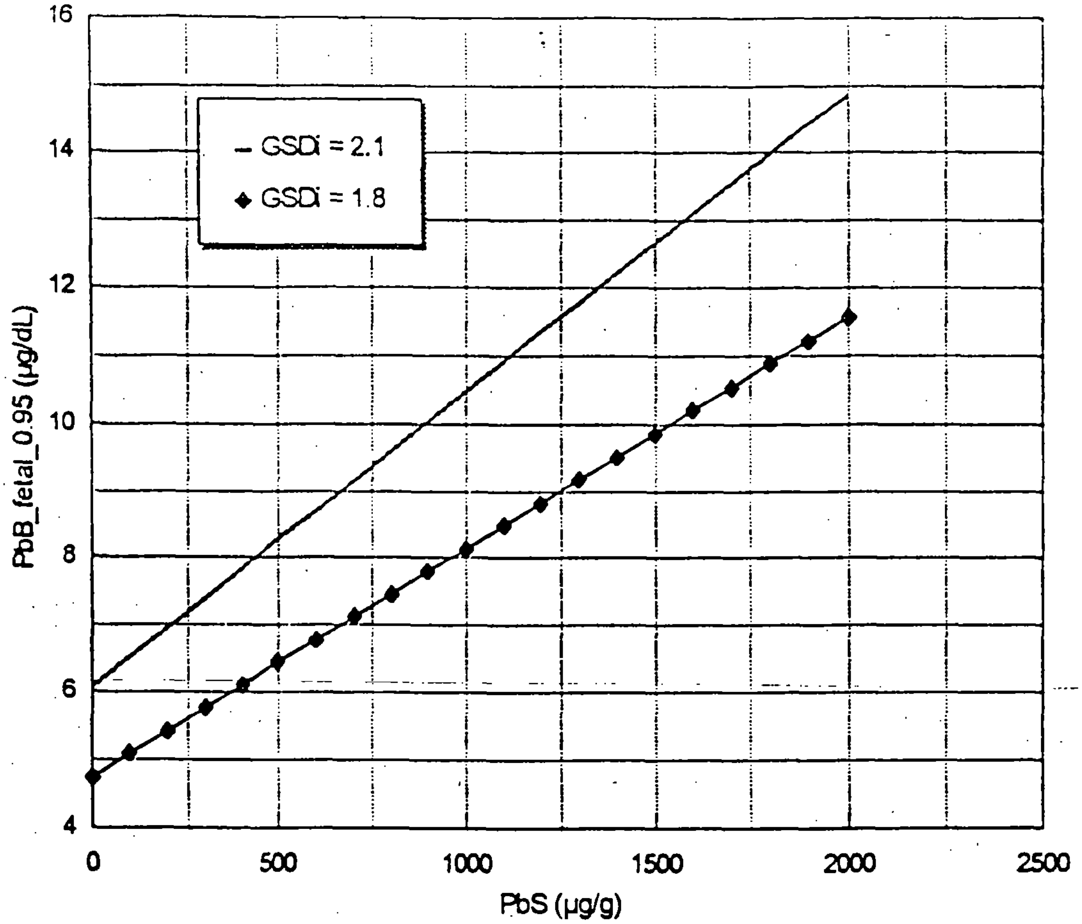

Figure 1. Example output of risk estimation algorithm (Equation 4) assuming a $PbB_{adult,0}$ of 2.0 µg/dL (mixed racial) and a $GSD_{i,adult}$ of either 1.8 (homogeneous population) or 2.1 (heterogeneous urban population).

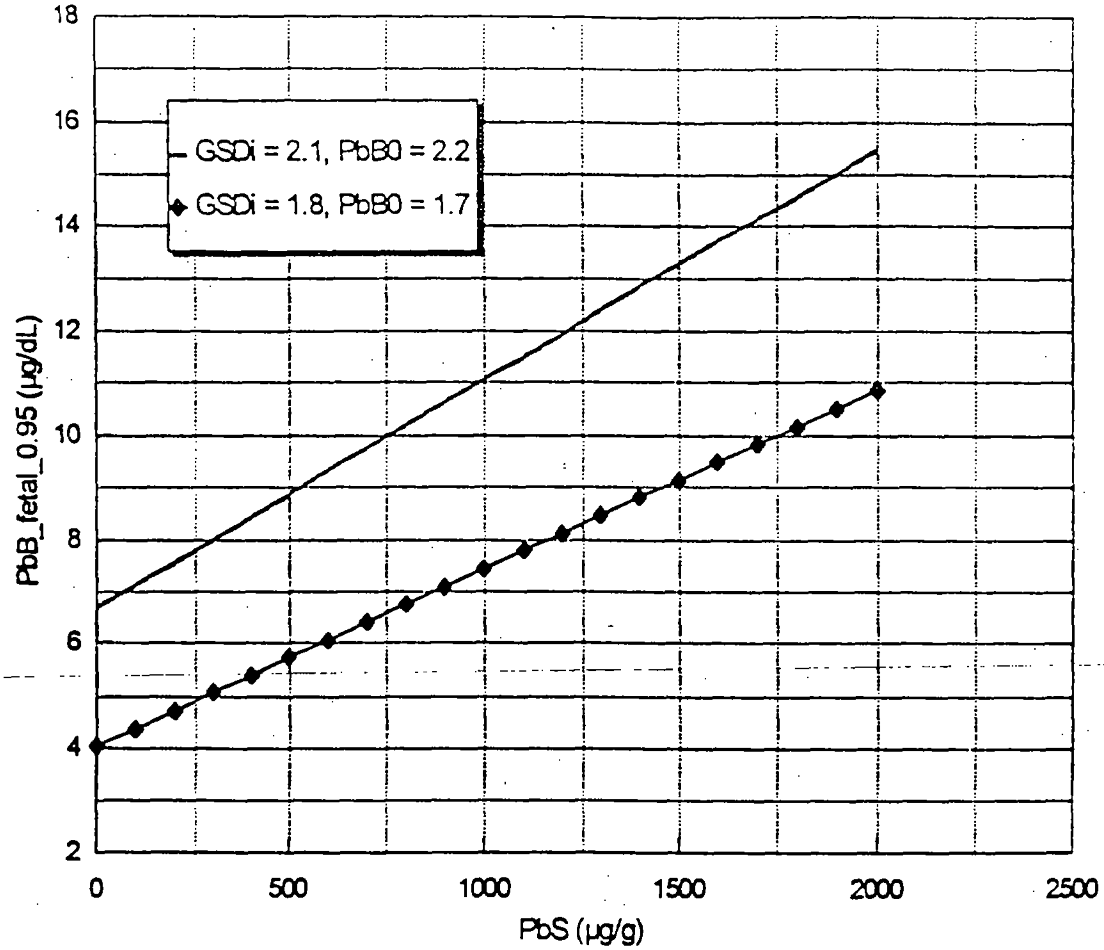

Figure 2. Example output of risk estimation algorithm (Equation 4) assuming plausible default minimum and maximum values of $PbB_{adult,0}$ (1.7 and 2.2 µg/dL) and $GSD_{i,adult}$ (1.8 and 2.1).

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APPENDIX

Equations and Rationale for Default Values Assigned to Parameters in the Slope Factor Approach and Exposure Model for Assessing Risk Associated with Adult Exposures to Lead in Soil

Equations and Rationale for Default Values Assigned to Parameters in the Slope Factor Approach and Exposure Model for Assessing Risk Associated with Adult Exposures to Lead in Soil

1. Equations for the Adult Lead Model A-3

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7. Daily Soil Ingestion Rate (IR_S) A-19

8. Exposure Frequency (EF_S) A-22

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1. Equations for the Adult Lead Model

The format of the equations used in the adult lead methodology follows the approach used in the IEUBK Model for Lead in Children (IEUBK Model). Note that the equations may consist of variables that include superscripts and/or subscripts. The convention adopted in this report is to use superscripts as exponents (i.e., a mathematical operation), whereas subscripts represent key words that provide additional information to distinguish between similar variables. The term "soil" refers to that portion of the soil to which adults are most likely to be exposed. In most cases, exposure is assumed to be predominantly to the top layers of the soil which gives rise to transportable soil-derived dust. Exposure to soil-derived dust occurs both in outdoor and indoor environments, the latter occurring where soil-derived dust has been transported indoors. Other types of dust, in addition to soil-derived dust, can contribute to adult lead exposure and may even predominate in some occupational settings; these include dust generated from manufacturing processes (e.g., grinding, milling, packaging of lead-containing material), road dust, pavement dust, and paint dust.

Exposure to lead from soil (direct and through indoor soil-derived dust) and lead intake:

$$INTAKE = \frac{PbS \cdot IR_S \cdot EF_S}{AT} \qquad \text{(Equation A-1)}$$

INTAKE = Daily average intake (ingestion) of lead from soil taken over averaging time AT (μg/day).

PbS = Soil lead concentration (μg/g) (appropriate average concentration for individual).

IR_S = Intake rate of soil, including outdoor soil and indoor soil-derived dust (g/day).

EF_S = Exposure frequency for contact with assessed soils and/or dust derived in part from these soils (days of exposure during the averaging period); may be taken as days per year for continuing, long term exposures.

AT = Averaging time; the total period during which soil contact may occur; 365 days/year for continuing long term exposures.

Lead uptake:

$$UPTAKE = AF_S \cdot INTAKE \qquad \text{(Equation A-2)}$$

UPTAKE = Daily average uptake of lead from the gastrointestinal tract into the systemic circulation (µg/day).

AF_S = Absolute gastrointestinal absorption fraction for ingested lead in soil and lead in dust derived from soil (dimensionless).

Central estimate of adult blood lead concentration:

$$PbB_{adult,central} = PbB_{adult,0} + BKSF \cdot UPTAKE \qquad \text{(Equation A-3)}$$

$PbB_{adult,central}$ = Central estimate of blood lead concentrations (µg/dL) in adults (i.e., women of child-bearing age) that have site exposures to soil lead at concentration, PbS.

$PbB_{adult,0}$ = Typical blood lead concentration (µg/dL) in adults (i.e., women of child-bearing age) in the absence of exposures to the site that is being assessed.

BKSF = Biokinetic slope factor relating (quasi-steady state) increase in typical adult blood lead concentration to average daily lead uptake (µg/dL blood lead increase per µg/day lead uptake).

Distributional model for adult blood lead:

In this methodology, variability in blood lead concentrations among a population is mathematically described by a lognormal distribution defined by two parameters, the geometric mean (GM) and the geometric standard deviation (GSD):

$$PbB_{adult} \sim Lognormal(GM, GSD)$$

PbB_{adult} = Adult blood lead concentration (which is a variable quantity having the specified probability distribution).

GM = Geometric mean blood lead concentration (µg/dL) for adults having site exposure. The central estimate of adult blood lead, $PbB_{adult,central}$, constructed in Equation A-3 is treated as a plausible estimate of the geometric mean.

GSD = Geometric standard deviation for blood lead concentrations among adults having exposures to similar on-site lead concentrations, but having non-uniform response (intake, biokinetics) to site lead and non-uniform off-site lead exposures. The individual blood lead concentration geometric standard deviation, GSD_i, is substituted for GSD. As described below (Section 2 of the Appendix), GSD_i is assumed to address sources of variability in blood lead concentrations among the exposed population.

Parameter estimates for the geometric mean (GM) and geometric standard deviation (GSD) of the lognormal distribution are described below. Note that blood lead concentrations for site exposures can be quantified at any percentile of the population using these parameters. For example, the 95th percentile blood lead concentration can be calculated by Equation A-4:

$$PbB_{adult,0.95} = PbB_{adult,central} \cdot GSD_i^{1.645} \qquad \text{(Equation A-4)}$$

$PbB_{adult,0.95}$ = 95th percentile blood lead concentration (µg/dL) among individuals having exposures to the specified site soil lead concentrations. This is interpreted to mean that there is a 95% likelihood that an adult exposed to the specified soil lead concentrations would have a blood lead concentration less than or equal to $PbB_{adult,0.95}$.

Distributional model for fetal blood lead:

$$PbB_{fetal} = R_{fetal/maternal} \cdot PbB_{adult} \qquad \text{(Equation A-5)}$$

PbB_{fetal} = Fetal blood lead concentration (µg/dL) (which, like PbB_{adult}, is a variable quantity having the specified probability distribution).

$R_{fetal/maternal}$ = Constant of proportionality between fetal and maternal blood lead concentrations.

PbB_{adult} = Adult blood lead concentration (µg/dL), estimated with parameters appropriate to women of child bearing age.

Note that this relationship implies a deterministic (non-random) relationship between maternal and fetal blood lead concentrations. This assumption omits a source of variability (varying individual-specific ratios of fetal to maternal blood lead) that would tend to increase the variance of fetal blood lead concentrations. The assumption of proportionality implies that fetal blood lead concentrations also are lognormally distributed:

$$PbB_{fetal} \sim Lognormal(GM, GSD)$$

GM = Geometric mean blood lead concentration (µg/dL) for fetuses, equal to $R_{fetal/maternal}$ multiplied by $PbB_{adult,central}$.

GSD = Geometric standard deviation of blood lead concentration among adults, GSD_i (Section 2 of the Appendix).

Similarly, percentiles of the fetal blood lead distribution can be estimated (for fetuses carried by women exposed to the specified concentration of lead at the assessed site). For example:

$$PbB_{fetal,0.95} = R_{fetal/maternal} \cdot PbB_{adult,central} \cdot GSD_{i,adult}^{1.645} \qquad \text{(Equation A-6)}$$

$PbB_{fetal,0.95}$ = 95th percentile blood lead concentration (µg/dL) among fetuses born to women having exposures to the specified site soil lead concentrations. This is interpreted to mean that there is a 95% likelihood that a fetus born, in a woman who experiences such exposures, would have a blood lead concentration no greater than $PbB_{fetal,0.95}$.

Note that when the expressions for $PbB_{adult,central}$, INTAKE, and UPTAKE (Equations A-1, A-2 and A-3) are substituted into Equation A-6, we obtain the complete expression for $PbB_{fetal,0.95}$ that is presented in the fact sheet (Overview of the Approach, Equations 1 and 2):

$$PbB_{fetal,0.95} = R_{fetal/maternal} \cdot GSD_i^{1.645} \cdot \left[\frac{(PbS \cdot BKSF \cdot IR_S \cdot AF_S \cdot EF_S)}{AT} + PbB_{adult,0}\right] \qquad \text{(Equation A-7)}$$

Equation A-7 represents variability in blood lead concentration arising from two main factors: 1) exposure variables, including inter-individual variability in activity-weighted ingestion rates, and 2) inter-individual variability in physiology, including factors affecting lead biokinetics.

2. Individual Blood Lead Geometric Standard Deviation (GSD_i)

The GSD_i is a measure of the inter-individual variability in blood lead concentrations in a population whose members are exposed to the same nonresidential environmental lead levels. Ideally, the value(s) for GSD_i used in the methodology should be estimated in the population of concern at the site. This requires data on blood lead concentration and exposure in a representative sample of sufficient size to yield statistically meaningful estimates of GSD in subsamples stratified by nonresidential exposure level. In the absence of high quality data for the site, GSD_i may be extrapolated from estimates for other surrogate populations. In making such extrapolations, factors that might contribute to higher or lower variability in the surrogate population than among similarly exposed individuals in the population of concern, should be evaluated. These factors include variability in exposure (level and pathways), and biokinetics (see Section 6 of Appendix), socioeconomic and ethnic characteristics, degree of urbanization and geographical location. Such extrapolations, therefore, are site-specific and are a potentially important source of uncertainty in the methodology.

GSD values measured in populations (GSD_p) reflect the combined effect of 1) variability in environmental concentration levels; and 2) activity-weighted exposures and lead biokinetics. Thus, estimates of GSD_p can be considered a surrogate for estimating the GSD_i. Site data on blood lead concentrations collected from populations of varying homogeneity may be useful for establishing a plausible range of values of GSD_i, provided that the data are of adequate quality and can be stratified by nonresidential exposure level. The lowest values of GSD_p are expected among homogeneous populations (e.g., individuals with simiiar socioeconomic and ethnic characteristics living within a relatively small geographic area) exposed to a single, dominant source of lead (e.g., lead mining or smelter sites). For example, a GSD_p of 1.8 was recently calculated among adult women living in Leadville, CO (U.S. EPA, 1995). This relatively low GSD is consistent with an analysis of blood lead concentration data in mining communities in the United States and Canada, which suggest that GSD_p ranges from 1.6 - 1.8 at active mining sites where blood lead concentrations are less than 15 µg/dL (U.S. EPA, 1992). By contrast, higher values of GSD_p might be expected from a national survey. Although lead exposures among the general population are likely to be more greatly impacted by diet than soil (e.g., compared with populations exposed at a waste site), the national population is very heterogeneous, in that it includes individuals with different socioeconomic and ethnic characteristics living in distinct geographic areas.

The TRW has conducted a preliminary analysis of blood lead concentration data collected in NHANES III Phase 1 from 1988 to 1991 and found that the GSD_p for women ages 17 to 45 years may range from 1.9 - 2.1 (Table A-1). Because of the complex survey design used in NHANES III (e.g., large oversampling of young children, older persons, black persons, and Mexican-Americans), this analysis used sampling weights included in the NHANES III Phase 1 data file to produce population estimates for blood lead concentration. The weighting factor "WTPEXMH1" was used to reflect the non-random sampling of individuals in both the mobile examination units (MEC) and the home examinations. The analysis did not account for the design effects associated with the selection of strata and primary sampling units (PSUs), which may result in an underestimation of sampling variance. Since this bias is not likely to greatly impact the GSD_p (Brody, personal communication), the amount of underestimation of the GSD_p by the values given in Table A-1 is likely to be small. Geometric mean blood lead concentrations listed in Table A-1 are within 0.2 µg/dL of these reported in Brody et al. (1994).

The TRW estimates that 1.8 - 2.1 is a plausible range for GSD_i, based on an evaluation of available blood lead concentration data for different types of populations. In cases where site-specific data are not available, a value within this range should be selected based on an assessment as to whether the population at the site would be expected to be more or less heterogeneous than the U.S. population with respect to racial, ethnic, cultural and socioeconomic factors that may affect exposure.

Table A-1. NHANES III Phase 1 Summary Statistics for Blood Lead Concentration Among U.S. Women by Age and Ethnic/Racial Characteristics[a].

Age Group (years)	Non-Hispanic White			Non-Hispanic Black			Mexican American		
	No.	GM	GSD	No.	GM	GSD	No.	GM	GSD
20 - 49	728	1.9	1.90	622	2.3	2.01	729	2.1	2.10
50 - 69	476	3.2	1.88	256	4.2	1.80	255	3.3	2.12
> 69	562	3.5	1.82	135	4.1	1.86	75	2.9	2.03
20 +	1,766	2.4	2.01	1,013	2.7	2.07	1,059	2.3	2.14
17 - 45	**742**	**1.7**	**1.89**	**658**	**2.1**	**1.98**	**763**	**2.0**	**2.10**

[a]Analysis of data weighted by MEC and home weighting factor (WTPEXMH1), excluding samples missing data on blood lead concentration or age. GM PbB (µg/dL) = $\exp(\mu_{ln})$; GSD PbB = $\exp(\sigma_{ln})$.

3. Fetal/Maternal Blood Lead Concentration Ratio ($R_{fetal/maternal}$)

The TRW recommends a default value of 0.9 based on studies that have explored the relationship between umbilical cord and maternal blood lead concentrations (Goyer, 1990; Graziano et al., 1990). The Goyer (1990) estimate of an average fetal/maternal blood lead concentration ratio of 0.9 is supported by a large body of data that has been summarized in Agency documents (U.S. EPA, 1986, 1990). Graziano et al. (1990) compared maternal and umbilical cord blood lead concentrations at delivery in 888 mother-infant pairs who were between 28 and 44 weeks of gestation. The relationship was linear with a slope of 0.93 µg/dL cord blood per µg/dL maternal blood; the correlation coefficient was 0.92. The slope of 0.93 from the Graziano et al. (1990) study supports 0.9 as a point estimate for $R_{fetal/maternal}$.

Although average fetal/maternal blood lead concentration ratios, as reflected in cord blood, tend to show consistent trends (Goyer, 1990; Graziano et al., 1990), the trends may not reflect significant inter-individual variability in maternal and possibly fetal blood lead concentrations due to physiological changes associated with pregnancy. For example, mobilization of bone lead stores during pregnancy may be more substantial in some women, and iron and calcium deficiency associated with poor nutritional status, as well as pregnancy, may enhance gastrointestinal absorption of lead (U.S. EPA, 1990; Franklin et al., 1995). Conversely, maternal blood lead concentration may decrease during the later stages of pregnancy because of the dilution effect associated with a 30% rise in plasma volume, as well as an increased rate of transfer of lead to the placenta or to fetal tissues (Alexander and Delves, 1981). These changes may give rise to fetal/maternal blood lead concentration ratios that are different from 0.9.

4. Baseline Blood Lead Concentration ($PbB_{adult,0}$)

The baseline blood lead concentration ($PbB_{adult,0}$) is intended to represent the best estimate of a reasonable central value of blood lead concentration in women of child-bearing age who are not exposed to lead-contaminated nonresidential soil or dust at the site. In this analysis, geometric mean blood lead concentrations are used for this purpose. Ideally, the value(s) for $PbB_{adult,0}$ used in the methodology should be estimated in the population of concern at the site. This requires data on blood lead concentrations in a representative sample of adult women who are not exposed to nonresidential soil or soil-derived dust at the site, but who may experience exposures to other environmental sources of lead that are similar in magnitude to exposures experienced by the population of concern. This would include exposure to lead in food and drinking water as well as residential soil and dust (dust derived from soil and all other non-site related sources). The sample must be of sufficient size to yield statistically meaningful estimates of $PbB_{adult,0}$.

In the absence of high quality data for the site, $PbB_{adult,0}$ may be extrapolated from estimates for other surrogate populations that would be expected to have a similar $PbB_{adult,0}$ distribution as that of the population of concern. In making such extrapolations, factors that might contribute to differences between the geometric mean $PbB_{adult,0}$ in the surrogate population and population of concern should be evaluated. These factors include differences in the residential exposure (level and pathways), socioeconomic, ethnic and racial demographics, housing stock, degree of urbanization, and geographical location. Such extrapolations, therefore, are site-specific.

In cases where site-specific extrapolations from surrogate populations are not feasible, the TRW recommends 1.7 - 2.2 µg/dL as a plausible range, based on the results of Phase 1 of the NHANES III as reported by Brody et al. (1994). Table A-2 summarizes the analysis of blood lead concentrations from a sample of 2,083 women ages 20 - 49, and stratified into the three ethnic and racial categories.

Table A-2. NHANES III Phase 1 Summary Statistics for Blood Lead Concentration Among Different Populations of U.S. Women Ages 20 - 49 (Brody et al., 1994).

Population	No.	GM (95% CI)
Mexican American women	732	2.0 (1.7 - 2.5)
non-Hispanic black women	623	2.2 (2.0 - 2.5)
non-Hispanic white women	728	1.7 (1.6 - 1.9)
Total	2,083	

The TRW recommends that the estimates from Table A-2 be used in combination with data on the ethnic and racial demographics of the population of concern to select the most appropriate point estimate from within the plausible range of 1.7 - 2.2 µg/dL. For example, if the population at the site was predominantly Mexican American, 2.0 µg/dL might be selected as the point estimate. The plausible range is based on surveys of large samples of the national population and may not encompass central tendencies estimated from smaller regional or site-specific surveys, either because of bias associated with the smaller sample or because of real differences between the surveyed population and the national population. This needs to be evaluated in deciding whether or not to use data from small surveys that yield point estimates for $PbB_{adult,0}$ that fall outside of the plausible range.

5. Biokinetic Slope Factor (BKSF)

The BKSF parameter relates the blood lead concentration (μg Pb/dL) to lead uptake (μg Pb/day). The TRW recommends a default value of 0.4 μg Pb/dL blood per μg Pb absorbed/day for the BKSF parameter based on data reported by Pocock et al. (1983) on the relationship between tap water lead concentrations and blood lead concentrations for a sample of adult males, and on estimates of the bioavailability of lead in tap water (see Section 6 of the Appendix).

Pocock et al. (1983) analyzed data on lead concentrations in first draw tap water and blood lead concentrations in a population of 910 adult males. A linear model imposed on the data yielded a slope of 0.06 (μg/dL per μg/L first draw water) for water lead concentrations equal to or less than 100 μg/L (a lower slope was applied to the data for higher water concentrations). Pocock et al. (1983) also obtained data on lead concentrations in flushed water (and "random daytime") samples, in addition to first draw samples. Given the following assumptions, it is possible to derive a slope factor for ingested water lead (INGSF) from the Pocock et al. (1983) data:

- The lead concentration of flushed water was 25% of the concentration of first draw water ($C_{f/1st} = 0.25$) (U.S. EPA, 1995).
- Daily water intake consisted of 30% first draw and 70% flushed ($F_{1st} = 0.3$, $F_f = 0.7$) (U.S. EPA, 1992).
- Daily water ingestion (including tap water and beverages made with tap water) was 1.4 L/day ($IR_W = 1.4$) (U.S. EPA, 1989).

Based on the above assumptions, a INGSF of 0.09 μg/dL per μg intake/day is estimated as follows:

$$INGSF = \frac{0.06}{IR_W \cdot (F_{1st} + (C_{f/1st} \cdot F_f))} \qquad \text{(Equation A-8)}$$

$$INGSF = \frac{0.06}{1.4 \cdot (0.3 + (0.25 \cdot 0.7))}$$

$$INGSF = 0.09$$

This suggests that the product of the BKSF, reflecting the slope for absorbed rather than ingested lead, and the absorption factor for lead in drinking water (AF_w) should be approximately 0.09 if it is to match the estimate of INGSF based on the Pocock et al. (1983) study:

$$INGSF = BKSF \cdot AF_w \qquad \text{(Equation A-9)}$$

Values of AF_w within the range 0.20 - 0.25 would correspond to a range for BKSF of 0.36 - 0.45, or approximately 0.4 µg/dL per µg/day (rounded to one significant figure). A range of 0.20 - 0.25 for AF_w is supported by data from numerous lead bioavailability studies (see Section 6 of the Appendix for a more detailed discussion of these studies).

The above estimate of 0.4 µg/dL per µg/day for the BKSF can be compared with the approach described by Bowers et al. (1994), who used the same data set along with different assumptions and arrived at essentially the same estimate of the BKSF, 0.375 or approximately 0.4 µg/dL per µg/day. Bowers et al. (1994) assumed a daily tap water intake of 2 L/day and 8% absorption of lead ingested in tap water; and did not make adjustments for a mixture of first draw and flushed water intake in the Pocock et al. (1983) study.

Several uncertainties should be considered in applying the default value of 0.4 µg/dL per µg/day to any specific population. Since it is based on the Pocock et al. (1983) data, it represents an extrapolation from adult men to women of child bearing age. Physiological changes associated with pregnancy may affect the value of the BKSF (see Section 6 of the Appendix); therefore, some uncertainty is associated with applying the default value to populations of pregnant women.

An additional uncertainty concerns the assumption of linearity of the relationship between lead intake and blood lead concentration. The Pocock et al. (1983) study provides data on a large sample population of adult men whose members were exposed to relatively low drinking water lead levels; 898 subjects (97%) were exposed to first draw water lead concentrations less than 100 µg/L and 473 (52%) to 6 µg/L or less. A smaller study of adult women exposed to higher concentrations was reported by Sherlock et al. (1982, 1984); out of 114 subjects, 32 (28%) had flush drinking water lead concentrations less than 100 µg/L and only 13 (11%) less than 10 µg/L. Sherlock et al. (1982, 1984) used a cube root regression model, rather than a linear model, to describe the relationship between drinking water and blood lead concentration. Given the much larger sample size in the Pocock et al. (1983) study, particularly towards the low end of the distribution for water lead concentration, greater confidence can be placed in the estimated slope of the linear regression model from the Pocock et al. (1983) study than in the cube root regression model of Sherlock et al. (1982, 1984). Nevertheless, it is useful to compare the output of the two models because they were applied to the different sexes and because they differ so fundamentally in the treatment of the blood lead - water lead slope; the slope is constant in the linear model and decreases in the cube root model as water lead concentration increases. Figure A-1 compares the output of the two models and shows the output of a linear regression of the unweighted output of the Sherlock et al. (1984) model. Three observations can be made from this comparison that are relevant to the BKSF:

1. Both the Pocock et al. (1983) and Sherlock et al. (1984) models predict higher blood lead concentrations than would be expected in the average U.S. population today as suggested from NHANES III. This is indicative of higher lead intakes in the study populations which may have contributed to the apparent nonlinearities observed (e.g. above 100 µg/L in Pocock et al.(1983) and at lower concentrations in Sherlock et al. (1984).

2. The cube root regression model of Sherlock et al. (1984) predicts lower blood lead

concentrations than the linear model of Pocock et al. (1983). This may reflect greater lead intakes from sources other than drinking water in the Pocock et al. (1983) population (see Section 6 of the Appendix for further discussion).

3. The linear approximation of the Sherlock et al. (1984) and the linear model from Pocock et al. (1983) have similar slopes; 0.08 and 0.06 µg/dL per µg/L, respectively. Thus, although the Sherlock et al. (1984) study casts some degree of uncertainty on the assumption of linearity of the blood lead - drinking water lead relationship both at low (<10 µg/L) and high (> 100 µg/L) tap water lead concentrations, a linear model with a constant slope of 0.06 µg/dL per µg/L appears to approximate the output of the nonlinear model of Sherlock et al. (1984) reasonably well for water lead concentrations less than 100 µg/L.

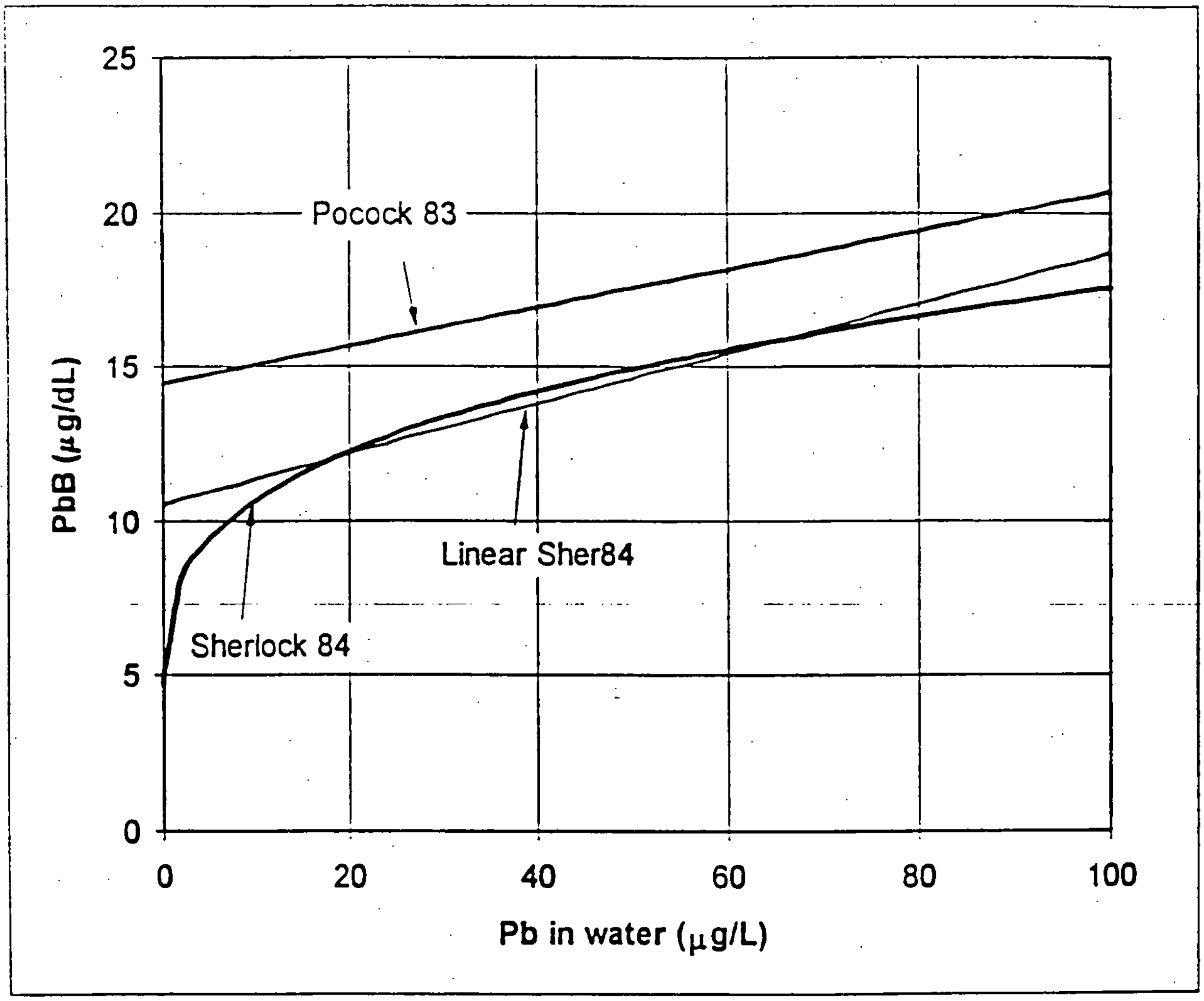

Figure A-1. Comparison of linear model of Pocock et al. (1983) with cube root model of Sherlock et al. (1984) and a linear model imposed on the unweighted output of the Sherlock model over the water lead range 0 - 100 μg/L (linear Sher84). The slope of the linear Sher84 model is 0.08 μg/dL per μg/L. The slope of the Pocock et al. (1983) model is 0.06 μg/dL per μg/L.

Experimental data on the pharmacokinetics of lead in adult humans support the default value of 0.4 (µg/dL per µg/day absorbed lead) for BKSF estimated from Pocock et al. (1983). Several distinct kinetic pools of lead are evident from observations of the rate of change of blood lead isotope with time after a period of daily dosing in which lead is abruptly terminated (Rabinowitz et al., 1976). A rapid exchange pool, denoted pool 1, includes the blood and a portion of the extracellular fluid, and is the physiological pool from which urinary and hepatobiliary excretion of blood lead occurs. Several estimates of the size of pool 1 (V_1) and the residence times for lead in pool 1 (T_1) have been derived from experiments in which human subjects were administered tracer doses of stable isotopes of lead from which pool 1 clearances (C_1) have been estimated; these estimates are summarized in Table A-3.

Table A-3. Summary of Experimental Studies with Humans to Assess Clearance Rates of Lead from Blood and Extracellular Fluid.

Subject	V_1[a] (dL)	T_1[b] (day)	$T_{1/2}$[c] (day)	C_1[d] (dL/day)	Reference
A	77	34	24	2.3	Rabinowitz et al., 1974
B	115	50	35	2.3	
A	74	34	24	2.2	Rabinowitz et al., 1976
B	100	40	28	2.5	
C	101	37	26	2.7	
D	99	40	28	2.5	
E	113	27	19	4.2	
ACC	70[e]	29	20	2.4	Chamberlain et al., 1978
DN	94[e]	39	27	2.4	
PL	85[e]	40	28	2.1	
ACW	94[e]	48	33	2.0	
MJH	97[e]	41	28	2.4	
ANB	95[e]	40	28	2.4	
Mean ± SD	93 ± 14	38 ± 6	27 ± 4	2.5 ± 0.5	

[a]The reported volume of pool 1, which refers to blood and rapidly exchangeable extracellular fluid compartment.
[b]The reported residence time for lead in pool 1.
[c]The half life of lead in pool 1; $T_{1/2} = (T_1) \times \ln(2)$.
[d]Clearance of lead from pool 1; $C_1 = V_1/T_1$.
[e]Estimated assuming $V_1 = V_{blood} \times 1.7$ (Rabinowitz et al., 1976).

The above experiments support a value for C_1 of 2.5 dL/day. At steady state, the clearance is equivalent to the rate of uptake of lead into pool 1 per unit of blood lead concentration (µg/day per µg/dL). Theoretically, this should correspond to a slope factor of 0.40 µg/dL per µg/day absorbed lead (i.e., the reciprocal of the clearance estimate). Thus, the default value for the BKSF parameter of 0.4 µg/dL per µg/day absorbed lead derived from the population survey data of Pocock et al. (1983) is consistent with the clearance estimates from experimental studies.

6. Soil Lead Absorption Factor (AF_S)

The AF_S parameter is the fraction of lead in soil ingested daily that is absorbed from the gastrointestinal tract. The TRW recommends a default value of 0.12 based on the assumption that the absorption factor for soluble lead ($AF_{soluble}$) is 0.2 and that the relative bioavailability of lead in soil compared to soluble lead ($RBF_{soil/soluble}$) is 0.6:

$$AF_S = AF_{soluble} \cdot RBF_{soil/soluble} \qquad \text{(Equation A-10)}$$

$$AF_S = 0.2 \cdot 0.6 = 0.12$$

The default value of 0.2 for $AF_{soluble}$ in adults represents a weight of evidence determination based on experimental estimates of the bioavailability of ingested lead in adult humans with consideration of three major sources of variability that are likely to be present in populations, but are not always represented in experimental studies; these are variability in food intake, lead intake, and lead form and particle size.

Effect of food on lead bioavailability. The bioavailability of ingested soluble lead in adults has been found to vary from less than 10% when ingested with a meal to 60 - 80% when ingested after a fast (Blake, 1976; Blake et al., 1983; Blake and Mann, 1983; Graziano et al., 1995; Heard and Chamberlain, 1982; James et al., 1985; Rabinowitz et al., 1976, 1980). The general consensus is that constituents of food in the gastrointestinal tract decrease absorption of ingested lead, although the exact mechanisms by which this occurs are not entirely understood. Lead intake within a population would be expected to occur at various times with respect to meals. Therefore, the central tendency for lead absorption would be expected to reflect, in part, meal patterns within the population and to have a value between the experimentally determined estimate for fasted and fed subjects.

An estimate of a "meal-weighted" $AF_{soluble}$ can be obtained from the data reported by James et al. (1985) and certain simplifying assumptions. James et al. (1985) assessed the effects of food on lead bioavailability by measuring the fraction retained in the whole body of adult subjects 7 days after they ingested a dose of radioactive lead either after a fast or at various times before or after a meal. The total lead dose was approximately 50 µg (fasted) - 100 µg (with food). Lead retention was 61 ± 8.2 (SD)% when lead was ingested on the 12th hour of a 19-hour fast and decreased to 4% - 16% when lead was ingested between 0 and 3 hours after a meal; retention was further reduced (3.5 ± 2.9%) when lead was ingested with a meal (breakfast) (the bioavailability may have been more than these retention estimates since some absorbed lead would have been excreted during the 7 day interval between dosing and measurement of whole-body lead). Since ingested material may be retained in the human stomach or at least 1 hour (Hunt and Spurrei, 1951; Davenport, 1971), lead bioavailability also may be reduced when lead is ingested 1 hour before a meal. The average "meal-weighted" bioavailability can be estimated based on the average number of waking hours during the day, the number of meals eaten, the bioavailability of lead ingested within 1 hour before a meal, the bioavailability of lead ingested within 0 to 3 hours after a meal, and the bioavailability of lead at other times during the day. For example, if it is assumed that people eat three meals each day and, based on the James et al. (1985) study, the bioavailability of lead ingested within 1 hour before a meal or 0 to 3 hours after a meal is approximately 0.1, and the bioavailability of lead ingested at all other times in a 16 hour day is 0.6, then the average "meal-weighted" bioavailability during a 16 hour day is approximately 0.2:

$$\frac{(0.1 \cdot 12\ hrs) + (0.6 \cdot 4\ hrs)}{16\ hrs} = 0.23$$

This example suggests that the use of 0.2 as a default value for $AF_{soluble}$ is plausible for populations in which soil lead intake occurs throughout the day, interspersed with meals. This may not apply to all members of a population. For example, the average bioavailability would be higher if less than three meals were consumed each day (e.g., using a similar calculation it can be shown that the average bioavailability for one meal each day would be 0.5). Average bioavailability also may be greater than 0.2 if lead intake was to occur predominantly in the early morning, before the first meal of the day.

Although lead bioavailability may be lower in individuals whose soil lead ingestion coincides with meals, the TRW cautions against the use of a value less than 0.2 for several reasons. Iron and calcium deficiency associated with poor nutritional status may enhance absorption (U.S. EPA, 1990). In addition, numerous factors may affect the absorption, distribution, excretion, and mobilization of lead during pregnancy: increased plasma volume (i.e., hemodilution); decreased hematocrit; previous exposure history of the mother (i.e., bone lead sequestration); changes in nutritional status; significant loss of body weight or depletion of fat stores; hormonal modulation; age; race; administration of drugs; and illness (Silbergeld, 1991). There is likely to be significant inter-individual variability in these factors, and studies of women at different stages of pregnancy have not shown clear trends in effects on blood lead concentration (Gershanik et al., 1974; Alexander and Delves, 1981; Baghurst et al., 1987; Silbergeld, 1991). While there is evidence to support 0.2 as a reasonable estimate of $AF_{soluble}$ for women of child-bearing age, there is still some basis for concern regarding potentially elevated absorption during pregnancy. However, a potential increase in lead absorption during pregnancy would be expected to occur dynamically with changes in bone mobilization, blood volume and glomerular filtration rate. Thus, the TRW cautions against adjusting the value for $AF_{soluble}$ (or BKSF) based on assumptions regarding the effects of pregnancy on blood lead concentration.

Nonlinearity in blood lead concentration. Another reason for caution in adopting values for $AF_{soluble}$ less than 0.2 derives from uncertainty about the relationship between blood lead concentration, lead intake, and lead absorption. Several studies have shown that the relationship between environmental lead levels (e.g., drinking water lead concentration) and blood lead concentration is nonlinear and suggest the possibility that fractional absorption of ingested lead is dose-dependent, and decreases as lead intake (and blood lead concentration) increases. Pocock et al. (1983) reported a nonlinear relationship between blood lead concentration and water lead that could be approximated by two linear equations: a slope of 0.06 µg/dL per µg/L was estimated for water lead concentrations equal to or less than 100 µg/L and a slope of 0.01 was estimated for water lead concentrations above 100 µg/L. Sherlock et al. (1982, 1984) used a cube root regression model to relate blood and water lead concentrations; however, over the range of water lead concentrations of 100 µg/L or less, the slope of 0.06 µg/dL per µg/L water lead from Pocock et al. (1983) approximates the relationship observed in the Sherlock et al. (1982, 1984) study (Figure A-1). The linear relationship between water lead and blood lead in the Pocock et al. (1983) study extends from a blood lead concentration range of 14 to 20 µg/dL. Based on these data, the value of $AF_{soluble}$ of 0.2 may be considered a reasonable default estimate if applied to exposure scenarios in which the estimates of blood lead concentration do not exceed 20 µg/dL. At blood lead concentrations greater than this, absorption of soluble lead may be less than the default value.

An appropriate value of $AF_{soluble}$ also can be supported by estimating the range of daily lead intake that is likely to result in a linear relationship between intake and blood lead concentration. Data represented in Figure A-1 suggest that if water lead concentrations are less than 100 µg/L, the blood lead - water lead relationship is approximately linear. If assumptions regarding the magnitude of first draw and flushed water intakes and lead concentrations are applied (see Equations A-8 and A-9 and discussion of BKSF), a first draw water lead concentration of 100 µg/L in the Pocock et al. (1983) study represents a water lead intake of approximately 70 µg/day:

$$100 \cdot 1.4 \cdot (0.3 + (0.25 \cdot 0.7)) \approx 70$$

We do not know with certainty the total lead intake in the Pocock et al. (1983) population, although we can be certain that it exceeded the above estimated intake from drinking water since intake from diet and other sources, including occupational, would have occurred; this is consistent with the higher blood lead concentrations that were observed in the male population. Sherlock et al. (1982) estimated that, in their study population of adult women, the dietary contribution to total lead intake was equal to that from drinking water when the water lead concentration was 100 µg/L, and that the contribution of lead from sources other than diet and water was very small. If the same assumption is applied to the Pocock et al. (1983) study, it is likely that total lead intake in the male population was at least 140 µg/day (70 µg/day from drinking water and 70 µg/day from diet; the Pocock et al., 1983 study included 40 households from the Sherlock et al., 1982 study site), and may have been higher because of occupational exposure in the male population. A crude estimate of the relative magnitudes of the non-water lead intakes in the two studies can be obtained by comparing the predicted water lead concentration required to achieve the same blood lead concentration in the two populations. For example, a water lead concentration of 100 µg/L corresponded to a predicted blood lead concentration of approximately 18 µg/dL in the female population (Sherlock et al., 1984); the same blood lead concentration corresponded to a water lead concentration of 50 µg/L in the male population (Pocock et al., 1983). Therefore, the non-water lead intakes in the male population may have been twice that in the female population. If it is assumed that drinking water and diet contributed equally to lead intake in both studies, then a drinking water lead concentration of 100 µg/L in the Pocock et al. (1983) study translates to a total lead intake of approximately 300 µg/day:

$$I_{total} = I_{water} + I_{diet} + I_{other} \qquad \text{(Equation A-11)}$$

$$I_{total} = 70 + 70 + 140 \approx 300\ \mu g/day$$

Thus, the departure from linearity observed in the Pocock et al. (1983) study may have occurred at lead intakes at or above 300 µg/day. In the various experimental assessments of lead bioavailability, subjects ingested lead in amounts that varied among the studies but were all within the range 100 - 300 µg (Blake, 1976; Blake et al., 1983; Blake and Mann, 1983; Graziano et al., 1995; Heard and Chamberlain, 1982; James et al., 1985; Rabinowitz et al., 1976, 1980), which is within the approximate linear range, if the extrapolation from the Pocock et al. (1983) and Sherlock et al. (1982) studies is reasonable. Based on these considerations, the value of $AF_{soluble}$ of 0.2 is considered to be a reasonable default value if applied to exposure scenarios in which lead intakes are less than 300 µg/day. At intakes greater than this, absorption of soluble lead may be less than the default value; however, it can be similarly argued that, based on the Sherlock et al. (1984) regression model, the default $AF_{soluble}$ may underestimate absorption by some degree at low exposures.

Effect of lead form and particle size on lead bioavailability. The default value of 0.2 for $AF_{soluble}$ applies to soluble forms of lead in drinking water and food and would be expected to overestimate absorption of less soluble forms of lead in soil. Experimental studies have shown that the bioavailability of lead in soil tends to be less than that of soluble lead. Weis et al. (1994) assessed the relative bioavailability of lead in soil compared to water soluble lead (acetate) in immature swine and estimated that the relative bioavailability of lead in soil from Leadville, CO was 0.6 to 0.8. Ruby et al. (1996) reported estimates of the relative bioavailability of lead in a variety of soils from mining sites and smelters as assessed in the Sprague-Dawley rat; the estimates ranged from 0.09 to 0.4. Maddaloni et al. (1996) reported preliminary data from a study in which 6 fasted human subjects were administered a single dose of lead-contaminated soil. The dose was 250 µg lead normalized to a 70 kg body weight; the concentration of lead in the soil was 2850 µg/g and the amount of soil administered to each subject was generally a little less than 100 mg. The average estimate of lead absorption in the six subjects was 26%. If the absorption factor for soluble lead in fasted adults is assumed to be 0.6 (James et al., 1985), then the Maddaloni et al. (1996) estimate suggests a relative bioavailability of 0.5 (i.e., 0.3/0.6) for lead in soil.

Based on the above evidence, the TRW considers 0.6 to be a plausible default point estimate for the relative bioavailability of lead in soil compared to soluble lead ($RBF_{soil/soluble}$) when site-specific data are not available. Such data are highly desirable as variation in relative bioavailability is expected for different species of lead and different particle sizes (Barltrop and Meek, 1975, 1979), both of which may vary from site to site. For example, the bioavailability of metallic lead has been shown to decrease with increasing particle size (Barltrop and Meek, 1979), therefore, the default value for $RBF_{soil/soluble}$ may overestimate absorption of lead if applied to soils contaminated with large lead particles such as firing range debris or mine tailings. Here again, the TRW cautions against the use of a lower value for the $RBF_{soil/soluble}$, unless it can be supported by experimental assessments of relative bioavailability.

The default value of 0.6 for $RBF_{soil, soluble}$, coupled with the default value of 0.2 for $AF_{soluble}$ yields a default value of 0.12 for AF_S (0.6 · 0.2). The TRW considers 0.12 to be a plausible point estimate for the absorbed fraction of ingested soil lead for use in assessments in which site-specific data on lead bioavailability are not available. The default value of 0.12 takes into account uncertainties regarding the possible nonlinearity in the relationship between lead intake and absorption and should be adequately protective in scenarios in which predicted blood lead concentrations are less than 20 µg/dL. The use of the default value for populations that have substantially higher blood lead concentrations may result in an overestimate of lead uptake, and conversely, lead uptake may be underestimated at lower exposures.

7. Daily Soil Ingestion Rate (IR_S)

The TRW recommends a default value of 0.05 g/day as a plausible point estimate of the central tendency for daily soil intake from all occupational sources, including soil in indoor dust, resulting from non-contact intensive activities. This would include exposures that are predominantly indoors. More intensive soil contact would be expected for predominantly outdoor activities such as construction, excavation, yard work, and gardening (Hawley, 1985). Site-specific data on soil contact intensity, including potential seasonal variations, should be considered in evaluating whether or not the default value is applicable to the population of concern and, if not, activity-weighted estimates of IR_S that more accurately reflect the site can be developed.

In adopting the single IR_S parameter to describe all sources of ingested soil, the methodology remains consistent with recommendations of the Superfund program and their implementation for risk assessment; specifically, the 0.05 g/day value used for adult soil ingestion addresses all occupational soil intake by the individual, whether directly from soil or indirectly through contact with dust (U.S. EPA, 1993). This value specifically applies to the assessment of soil lead risk, and not risks associated with non-soil sources of lead in dust. In making soil ingestion exposure estimates under the Risk Assessment Guidelines for Superfund (RAGS) framework, no specific assumptions are needed about the fraction of soil intake that occurs through dust.

An alternative approach was needed in the IEUBK Model because childhood lead exposures are often strongly influenced by indoor sources of lead in dust (e.g., indoor paint) (U.S. EPA, 1994b). In a situation where indoor sources of dust contamination are important, an exposure estimate that addresses only soil exposures (including the soil component of dust) would be incomplete. The IEUBK Model assigns separate values to outdoor soil and total indoor dust ingestion and partitions the indoor dust into soil-derived and non-soil-derived sources. At a minimum, paired soil and indoor dust samples should be collected to adequately characterize exposure to lead where indoor sources of dust lead may be significant.

Alternate method for calculating soil and dust ingestion as separate exposure pathways. In this alternate approach, separate estimates are made of lead intake from the direct ingestion of outdoor soil and from the ingestion of indoor dust (which may contain lead from soil and as well as from indoor sources such as deteriorated lead based paint). Exposure to lead from soil (outdoor contact) can be calculated using Equation A-12, while exposure to lead from indoor dust can be calculated using Equation A-13.

$$INTAKE_{S,outdoors} = \frac{PbS \cdot IR_{S,outdoors} \cdot EF_{Site}}{AT} \quad \text{(Equation A-12)}$$

$$INTAKE_{D,indoors} = \frac{PbD \cdot IR_{D,indoors} \cdot EF_{Site}}{AT} \quad \text{(Equation A-13)}$$

$INTAKE_{S,\ outdoors}$	=	Daily average intake (ingestion) of lead from soil ingested outdoors (μg/day).
$INTAKE_{D,\ indoors}$	=	Daily average intake (ingestion) of lead from dust ingested indoors (μg/day).
PbS	=	Soil lead concentration (μg/g) (average concentration in assessed individual exposure area).
PbD	=	Indoor dust lead concentration (μg/g).
$IR_{S,\ outdoors}$	=	Intake rate (ingestion) of outdoor soil (g/day).
$IR_{D,\ indoors}$	=	Intake rate (ingestion) of indoor dust (g/day).
EF_{Site}	=	Exposure frequency at site (days of exposure during the averaging period); may be taken as days per year for continuing, long term exposures.
AT	=	Averaging time, the total period during which the assessed exposures (from all sources) occur (days). May be taken as 365 days per year for continuing, long term exposures.

Note that, in Equations A-12 and A-13, exposure frequency refers to the number of days that an individual is present at the site and does not partition between periods of indoor and outdoor exposures. The intake rate is a long term average value appropriate for that media and is influenced by both the duration of outdoor (or indoor) exposures and the intensity of those exposures.

Calculation of $IR_{S,\ outdoors}$ and $IR_{D,\ indoors}$ from total intake of soil and dust (IR_{S+D}). Intermediary calculations may be needed to generate estimates of the parameters in the intake equations. An estimate of the total intake of soil and dust materials (IR_{S+D}) serves as a starting point. Note that IR_{S+D} differs from $IR_{S,}$ which was discussed above, because IR_{S+D} includes not only the total mass of soil ingested (both directly and as a component of indoor dust), but also the ingested mass of non-soil derived dust components including various materials of indoor origin. Since a substantial fraction of the mass of indoor dust comes from sources other than outdoor soils, an estimate of IR_{S+D} will be higher than the corresponding estimate of IR_S. Secondly, an estimate of the fraction the total soil and dust intake that is ingested directly as soil is needed ($Weighting_{soil}$). This estimate needs to take into account the intensity and duration of the outdoor soil intake and the indoor dust intake. Equations A-14 and A-15 can be used to derive media-specific ingestion rates from IR_{S+D} and $Weighting_{soil}$.

$$IR_{S,outdoors} = Weighting_{soil} \cdot IR_{S+D} \qquad \text{(Equation A-14)}$$

$$IR_{D,indoors} = (1 - Weighting_{soil}) \cdot IR_{S+D} \qquad \text{(Equation A-15)}$$

$Weighting_{soil}$ = Fraction of total soil and dust intake that is directly ingested as soil (dimensionless).

IR_{S+D} = Total daily average intake of outdoor soil and indoor dust (all dust components) (g/day).

Data are needed to generate separate estimates of the concentrations of lead in outdoor soil and in indoor dust. A site assessment using this alternate methodology would generally be based on direct measurement data for both soil and dust at the facilities of concern. For comparison with exposure estimates based on total soil ingestion (the primary approach presented in this paper), Equation A-16 may be utilized to estimate the ratio of dust lead concentration to soil lead concentration.

$$PbD = PbS \cdot K_{SD} \qquad \text{(Equation A-16)}$$

K_{SD} = Ratio of indoor dust lead concentration to soil lead concentration (dimensionless).

Assuming that the same absorption fraction is applicable to both soil and dust, Equation A-17 may be used to estimate the uptake of lead from these two sources.

$$UPTAKE = AF_{S,D} \cdot (INTAKE_{S,outdoors} + INTAKE_{D,indoors}) \qquad \text{(Equation A-17)}$$

UPTAKE = Daily average uptake of lead from the gastrotintestinal tract into the systemic circulation; soil and dust sources (μg/day).

$AF_{S,D}$ = Absolute gastrointestinal absorption fraction for ingested lead in soil and dust (dimensionless).

Comparison of lead intake estimated from principal and alternate approaches. It is helpful to compare exposure estimates derived using our principal approach based on total soil intake (including soil present in ingested dust) with the results of the disaggregated pathway analysis for soil and dust. We will consider the case in which there are not important indoor sources of lead in dust. We can then compare the total lead intake estimates from the two approaches.

Under the model based on total soil ingestion (which we re-label as $IR_{S,total}$ for clarity):

$$INTAKE = \frac{PbS \cdot IR_{S,total} \cdot EF_{Site}}{AT} \qquad \text{(Equation A-18)}$$

By contrast, using the disaggregated soil and dust model, Equations A-14, A-15, A-16, and A-18 may be combined to give Equation A-19:

$$INTAKE = \frac{PbS \cdot IR_{S+D} \cdot (Weighting_{soil} + K_{SD} \cdot (1 - Weighting_{soil})) \cdot EF_{Site}}{AT} \qquad \text{(Equation A-19)}$$

When applied to the same exposure assessment problem, the two approaches should give equivalent estimates of lead intake. The estimates will be equivalent when:

$$IR_{S+D} \cdot (Weighting_{soil} + K_{SD} \cdot (1 - Weighting_{soil})) = IR_{S,total}$$

8. Exposure Frequency (EF_S)

The TRW recommends a default value of 219 days/year. This is the same as the central tendency occupational exposure frequency recommended by U.S. EPA (1993) Superfund guidance, which is based on 1991 data from the Bureau of Labor Statistics. This estimate corresponds to the average time spent at work by both full-time and part-time workers engaged in non-contact intensive activities (U.S. EPA, 1993). Site-specific data on exposure frequency should be considered in evaluating whether or not the default value is applicable to the population of concern. In evaluating site-specific data, it should be kept in mind that exposure frequency and daily soil ingestion rate (IR_S) may be interdependent variables, particularly in contact-intensive scenarios; therefore, the assignment of a site-specific value to EF_S should prompt an evaluation of the applicability of the default value for IR_S to the population of concern (see Section 7 of the Appendix for further discussion).

Nonresidential exposure scenarios in which exposure frequency would be substantially less than 219 days/year are frequently encountered. Examples include trespassing and recreational use of a site. Important methodology constraints on exposure frequency and duration must be considered in assigning values to EF_S that would represent infrequent contact with the site; these constraints relate to the steady state assumptions that underlie the BKSF. The BKSF derived from the Pocock et al. (1983) data applies to exposures that result in a quasi-steady state for blood lead concentration; that is, an intake over a sufficient duration for the blood lead concentration to become nearly constant over time. Based on estimates of the first order elimination half-time for lead in blood of approximately 30 days for adults (Rabinowitz, et al., 1974, 1976; Chamberlain et al., 1978), a constant lead intake rate over a duration of 90 days would be expected to achieve a blood lead concentration that is sufficiently close the quasi-steady state. This is the minimum exposure duration to which this methodology should be applied.

Infrequent exposures (i.e., less than 1 day per week) over a minimum duration of 90 days would be expected to produce oscillations in blood lead concentrations associated with the absorption and subsequent clearance of lead from the blood between each exposure event. Based on the above assumptions about the elimination half-time lead in blood, the TRW recommends that this methodology should not be applied to scenarios in which EF_S is less than 1 day/week.

9. Applying Monte Carlo Analysis to the Adult Lead Methodology

Recent EPA guidance (Browner, 1995) recommends that risk assessments include a clear and transparent discussion of variability and uncertainty. The lead risk assessment methodology presented here develops explicit estimates of the variability of blood lead levels among adults who are exposed to specified concentrations of environmental lead. This analysis relies on data from a large number of studies (baseline blood lead levels, variability of blood lead levels, contact rates with environmental media, lead bioavailability, and lead biokinetics) to support a predictive probabilistic (lognormal) model for adult and fetal blood lead concentrations. Important issues regarding the uncertainty in parameter inputs and the mathematical form of the model are discussed in the sections of this Appendix. The TRW recognizes that there is considerable scientific interest in the different analytical approaches that may be applied to aid in the analysis of variability and uncertainty in risk assessments. In particular, under appropriate circumstances, Monte Carlo methods may provide a useful approach for developing quantitative estimates of the variability, uncertainty (or both) in risk predictions.

The TRW chose not to pursue application of Monte Carlo or other stochastic simulation methods in this effort addressing adult lead risk assessment. Several factors went into this decision. First, the TRW understood the needs of EPA Regions for a risk model that could be developed relatively rapidly and which Regional lead risk assessors could apply easily with limited need for additional study or training. These considerations made it advantageous to focus on models that are conceptually similar to the IEUBK model for children in terms of applying a parametric lognormal modeling approach to address distributions for blood lead levels. Secondly, the TRW recognized that there would be substantial scientific issues associated with developing widely applicable stochastic simulation models for adult lead risk assessment. These difficulties primarily relate to the absence of reliable distributional data for a variety of important variables in the assessment. As one example, very limited data are available on soil ingestion rates in adults and a distributional choice for this key parameter would depend heavily on individual judgement with little Agency precedent for support. Additionally, in a stochastic assessment, a greater complexity would arise due to likely correlations among the variables in the adult lead risk assessment. Stochastic analyses need to explicitly account for important correlations among variables if the simulations are to provide realistic distributions of risk. As an example, dependence is likely to exist between the starting (non-site related) blood lead concentrations for individuals and their site-related increases in blood lead. This dependence may result from individual patterns of behavior and from biological factors associated with lead pharmacokinetics. However, data on this dependence are sparse or absent, and the necessary statistical estimates of the correlation strength would depend heavily on personal judgement.

The TRW does encourage further efforts to better define the distributional data on which stochastic simulations of lead risks might rest. Further attention to these data can provide useful insights for lead risk assessment. The TRW also recognizes that Regions may be presented with lead risk assessments based on Monte Carlo modeling. In order to facilitate review of Monte Carlo analyses, some EPA Regions have found it important to establish requirements for the orderly development and review of these assessments. Borrowing on this approach, the TRW recommends that:

- A plan for the use of Monte Carlo analysis in a lead risk assessment should be submitted to responsible Regional personnel and accepted by them before the Monte Carlo analysis is undertaken.

- In general, it is expected that site-specific exposure related parameters that are supported with site-specific information will provide the basis for proposed Monte Carlo simulations.

- Scientific review is needed to determine that the risk assessment conformed to the plan and to evaluate the reliability of the results.

These recommendations are designed to ensure that assessments can provide meaningful results that can be understood and evaluated. If analyses are submitted in a format that is difficult to understand, the utility of the analysis will be diminished. We recommend that Regional staff seek advice from the TRW as a resource in this process.

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ATTACHMENT 3 - DESCRIPTIONS OF ORIGINAL 18 ALTERNATIVES

TABLE 5.1-3
DEFINITION OF CANDIDATE ALTERNATIVES

	ALTERNATIVE DESCRIPTION
ALTERNATIVE 1	SOURCE MATERIALS - No Action. GROUND WATER - No Action. SURFACE WATER - No Action.
ALTERNATIVE 2	SOURCE MATERIALS - Mill wastes in yards of existing residences confirmed to be built on former mill waste piles would be remediated by excavation and removal and/or on-site containment methods. Institutional controls would be implemented to prevent future residential development on mill waste areas without first remediating the homesites. GROUND WATER - Ground-water RAO No. 1 would be addressed by eliminating or reducing metal loadings from the Bruger shafts by reducing surface recharge to the Bruger workings, passive in-mine biological treatment, or collection and storage of Bruger discharges. RAO No. 2 would be met by not diverting surface-water flows or placing mill wastes into mine workings in hydraulic connection with workings in the Tar Creek Superfund Site. Current and future residences would be required to be connected to existing treated water supplies through institutional controls prohibiting the domestic use of shallow ground water (RAO No. 3). A search for abandoned deep bore holes and wells would be made and those located would be plugged. Strict design standards for the construction of new wells would be instituted for future protection of the deep aquifer (RAO No. 4). SURFACE WATER - No action is required to address RAO No. 1 since no ARARs exceedances in the Spring and Neosho Rivers were attributable to subsite sources. RAO No. 2 would be addressed in Willow Creek through reduction of metal loadings from the Bruger shafts. Enforcement of existing federal and/or state water quality regulations at currently operating facilities may also reduce metal loadings in subsite streams.
ALTERNATIVE 3	SOURCE MATERIALS - Mill wastes in yards of existing residences confirmed to be built on former mill waste piles would be remediated by excavation and removal and/or on-site containment methods. Institutional controls would be implemented to prevent future residential development on mill waste areas exceeding 600 mg/kg lead, 23,464 mg/kg zinc, and/or 120 mg/kg cadmium, without first remediating the homesites. GROUND WATER - Same as Alternative 2. SURFACE WATER - No action is required to address RAO No. 1. RAO No. 2 would be addressed in Willow Creek through reduction of metal loadings from the Bruger shafts. Additionally, RAO No. 2 would be addressed through removal and on-site disposal of all outwash tailings in both subsites. Appropriate source containment, drainage, and erosion control actions would be implemented to prevent the future release of tailings to subsite streams. The excavated outwash tailings would be placed in tailings impoundments which would then be capped in place with soil/clay cover systems to prevent future releases.

TABLE 5.1-3 (CONTINUED)
DEFINITION OF CANDIDATE ALTERNATIVES

	ALTERNATIVE DESCRIPTION
ALTERNATIVE 4a	SOURCE MATERIALS - Same as Alternative 2. GROUND WATER - Same as Alternative 2. SURFACE WATER - No action is required to address RAO No. 1. RAO No. 2 would be addressed in Willow Creek by controlling metal loadings from the Bruger shafts and through containment actions performed on the largest zinc loading sources in both the Spring Branch and Tar Creek drainages. Outwash tailings deposits deemed to rank among the largest metal loading sources would be excavated, removed, and disposed of in the mill waste areas to be remediated. Drainage/erosion control actions would also be implemented to augment the containment actions, as appropriate.
ALTERNATIVE 4b	SOURCE MATERIALS - Same as Alternative 2. GROUND WATER - Same as Alternative 2. SURFACE WATER - No action is required to address RAO No. 1. RAO No. 2 would be addressed by controlling metal loadings from the Bruger shafts in Willow Creek and through source removal and on-site disposal actions performed on the largest zinc and cadmium loading sources in both the Spring Branch and Tar Creek drainages, including some outwash tailings deposits. Excavated mill wastes would be disposed of in surface mine openings within the subsites determined not to be connected to the workings in the Tar Creek Superfund Site. Drainage/erosion control actions would also be implemented, as appropriate.
ALTERNATIVE 5a	SOURCE MATERIALS - Same as Alternative 2. GROUND WATER - Same as Alternative 2. SURFACE WATER - No action is required to address RAO No. 1. RAO No. 2 would be addressed through containment actions performed on all significant zinc and cadmium loading sources in both the Spring Branch and Tar Creek drainages. Some removal and drainage/erosion control actions would also be implemented to augment the containment actions. Metal loadings to Willow Creek from the Bruger shafts would be controlled.

TABLE 5.1-3 (CONTINUED)
DEFINITION OF CANDIDATE ALTERNATIVES

	ALTERNATIVE DESCRIPTION
ALTERNATIVE 5b	SOURCE MATERIALS - Same as Alternative 2. GROUND WATER - Same as Alternative 2. SURFACE WATER - No action is required to address RAO No. 1. RAO No. 2 would be addressed through excavation and on-site disposal of significant zinc and cadmium loading sources in both the Spring Branch and Tar Creek Drainages. Excavated materials would be placed in mine openings and/or on-site repositories for disposal. Removal actions would be confined to the immediate areas around streams and ponds. Source removal actions would be augmented by drainage/erosion actions. Metal loadings to Willow Creek from the Bruger shafts would also be controlled.
ALTERNATIVE 5c	SOURCE MATERIALS - Same as Alternative 2. GROUND WATER - Same as Alternative 2. SURFACE WATER - No action is required to address RAO No. 1. RAO No. 2 would be addressed through surface-water treatment in the form of conventional metals precipitation in addition to the same source containment, removal, and drainage/erosion controls prescribed under Alternative 5a. Centralized surface-water treatment plants would be located in both the Spring Branch and Tar Creek drainages. Other actions would include construction of collection and detention basins for flow equalization. Water treatment sludges would be disposed of in accordance with action-specific ARARs, depending on their chemical characteristics. Metal loadings to Willow Creek from the Bruger shafts would also be controlled.
ALTERNATIVE 5d	SOURCE MATERIALS - Same as Alternative 2. GROUND WATER - Same as Alternative 2. SURFACE WATER - The same surface-water actions would be implemented as in Alternative 5c except that passive biological treatment, instead of conventional chemical precipitation, would be performed through construction of passive wetland treatment systems in both the Spring Branch and Tar Creek drainages for the purpose of reducing zinc and associated cadmium concentrations. Metal loadings to Willow Creek from the Bruger shafts would be controlled.

TABLE 5.1-3 (CONTINUED)
DEFINITION OF CANDIDATE ALTERNATIVES

	ALTERNATIVE DESCRIPTION
ALTERNATIVE 6a	SOURCE MATERIALS - To address RAO No. 1, mill wastes in the yards of existing residences confirmed to be built on former mill waste piles would be remediated by excavation and removal and/or on-site containment methods. Institutional controls would not be implemented to prevent future residential development on mill waste sites or raise garden produce on mill wastes. Instead, all mill waste piles exceeding 1,000 mg/kg lead, 23,464 mg/kg zinc, and/or 120 mg/kg cadmium, except for large volume chat piles, would be remediated by capping in place with vegeated soil and soil/clay cover systems designed to protect possible future residents from direct exposures to metals in the wastes. Large volume chat piles would be considered potential future resources and would remain unremediated. GROUND WATER - Same as Alternative 2 except that institutional controls to prevent future consumption of shallow ground water would not be implemented. SURFACE WATER - No action is required to address RAO No. 1. RAO No. 2 would be addressed in Willow Creek through reduction of metal loadings from the Bruger shafts. Additionally, RAO No. 2 would be addressed through removal and on-site disposal of all outwash tailings in both subsites. Appropriate drainage and erosion controls would be implemented to prevent the future release of tailings to subsite streams. The excavated outwash tailings would be placed in the tailings impoundments to be remediated under the source materials actions prior to capping.
ALTERNATIVE 6b	SOURCE MATERIALS - Same as Alternative 6A except that mill waste piles, other than large volume chat piles, exceeding 1,000 mg/kg lead, 23,464 mg/kg zinc, and/or 120 mg/kg cadmium would be remediated by excavation and on-site disposal in surface mine openings determined not to be connected to workings in the Tar Creek Superfund Site. GROUND WATER - Same as Alternative 6A. SURFACE WATER - Same as Alternative 6A except that the excavated outwash tailings and their sources would be placed in surface mine openings determined not to be connected to workings in the Tar Creek Superfund Site.
ALTERNATIVE 6c	SOURCE MATERIALS - Same as Alternative 6B except that mill waste piles, other than large volume chat piles, exceeding 1,000 mg/kg lead, 23,464 mg/kg zinc, and/or 120 mg/kg cadmium would be remediated by excavation and on-site disposal in engineered waste repositories located in each subsite. GROUND WATER - Same as Alternative 6A. SURFACE WATER - Same as Alternative 6B except that the excavated outwash tailings and their sources would be excavated and placed in engineered repositories located in each subsite.

TABLE 5.1-3 (CONTINUED)
DEFINITION OF CANDIDATE ALTERNATIVES

	ALTERNATIVE DESCRIPTION
ALTERNATIVE 7a	SOURCE MATERIALS - To address RAO No. 1, mill wastes in yards of existing residences confirmed to be built on former mill waste piles would be remediated by excavation and removal and/or on-site containment methods. Institutional controls would not be implemented to prevent future residential development on mill waste sites. Instead, all mill waste except for large volume chat piles, would be remediated by capping in place with vegetated soil and soil/clay cover systems designed to protect possible future residents from direct human exposures to metals in the wastes. Large volume chat piles would be considered a potential future resource and remain unremediated. GROUND WATER - Same as Alternative 2 except that institutional controls to prevent future consumption of shallow ground water would not be implemented. SURFACE WATER - No action is required to address RAO No. 1. RAO No. 2 would be addressed in Willow Creek through reduction of metal loadings from the Bruger shafts. Additionally, RAO No. 2 would be addressed through removal and on-site disposal of all outwash tailings in both subsites. Appropriate drainage and erosion controls would be implemented to prevent the future release of tailings to subsite streams. The excavated outwash tailings would be placed in the tailings impoundments to be remediated under the source materials actions prior to capping.
ALTERNATIVE 7b	SOURCE MATERIALS - Same as Alternative 7A except that mill wastes, other than large volume chat piles, would be remediated by excavation and on-site disposal in surface mine openings determined not to be connected to workings in the Tar Creek Superfund Site and/or placed in an on-site repository. GROUND WATER - Same as Alternative 7A. SURFACE WATER - Same as Alternative 7A except that the excavated outwash tailings would be placed in surface mine openings determined not to be connected to workings in the Tar Creek Superfund Site.
ALTERNATIVE 7c	SOURCE MATERIALS - Same as Alternative 7B except that mill wastes, other than large volume chat piles, would be remediated by excavation and on-site disposal in engineered waste repositories located in each subsite. GROUND WATER - Same as Alternative 7A. SURFACE WATER - Same as Alternative 7A except that the excavated outwash tailings would be placed in engineered waste repositories in each subsite.

TABLE 5.1-3 (CONCLUDED)
DEFINITION OF CANDIDATE ALTERNATIVES

	ALTERNATIVE DESCRIPTION
ALTERNATIVE 8a	SOURCE MATERIALS - The source materials RAOs would be addressed through complete removal and on-site disposal of all source materials in both subsites. This alternative assumes wastes would be placed in on-site engineered repositories located in both subsites. Institutional controls would not be implemented except to prevent future disturbance of the on-site disposal areas. GROUND WATER - Same as Alternative 2. SURFACE WATER - Surface water RAOs would be addressed through the excavation, removal, and on-site disposal of all source materials in the Spring Branch and Tar Creek drainages, as described under source materials actions, above. Metal loadings to Willow Creek from the Bruger shafts would be controlled.
ALTERNATIVE 8b	SOURCE MATERIALS - The source materials RAO would be addressed through the same actions prescribed in Alternative 8a except that all usable chat would be processed for recovery and sale of aggregate values. Chat processing is expected to reduce the volume of materials to be disposed of by approximately 2.4 million cubic yards. The remaining mill wastes would be placed in engineered repositories, as proposed for Alternative 8A. Other actions could include segregation of excavated materials according to particle size and metals concentrations, and capping of filled mine shafts and subsidence pits. GROUND WATER - Same as Alternative 2. SURFACE WATER - Same as Alternative 8a.
ALTERNATIVE 8c	SOURCE MATERIALS - Same as Alternative 8A except that all excavated chat areas would be remediated by regrading, placing 12 inches of clean soil over the surfaces of the piles, and revegetating to protect potential future residents from ingestion of metals. Institutional controls would not be implemented except to prevent future disturbance of the on-site disposal areas. GROUND WATER - Same as Alternative 2. SURFACE WATER - Surface water RAOs would be addressed through the excavation, removal, and on-site disposal of all tailings and chat in the Spring Branch and Tar Creek drainages, as described under source materials actions, above. Metal loadings to Willow Creek from the Bruger shafts would be controlled.

ATTACHMENT 4 - TECHNICAL IMPRACTICABILITY WAIVER

Attachment #4

Additional Technical Impracticability Information

Purpose

This technical impracticability (TI) attachment to the Record of Decision (ROD) for the Baxter Springs and Treece subsites, operable units #03 and #04 (OU-3/4), of the Cherokee County, Kansas site is provided for additional clarification of the TI aspects of the selected remedy. This information compliments sections 9.2 and 11.0 of the ROD. The reader should refer back to these ROD sections for additional detail as this attachment is intended as a supplement to the existing provided information.

The TI justification for this action is based on the fact that legally applicable or relevant and appropriate requirements (ARARs) compliance would be inordinately costly from an engineering perspective. Chemical-specific ARARs under the Clean Water Act (CWA) regulating surface water quality and the Safe Drinking Water Act (SDWA) regulating groundwater drinking water will not be met by the selected remedy due to technical impracticability based on an inordinately costly determination.

Background

The Baxter Springs and Treece subsites collectively encompass approximately 28 square miles or nearly 18,000 acres and contain an estimated 4.3 million cubic yards of mining wastes. These subsites are a small component of the larger Cherokee County Superfund site (115 square miles). The Cherokee County site is a component of the much larger Tri-State Mining District which is estimated at approximately 500 square miles and covers portions of southeast Kansas, southwest Missouri, and northeast Oklahoma. The Tri-State District was mined for approximately 100 years from the mid to late 1800s to the mid 1970s.

Three Environmental Protection Agency (EPA) National Priority List (NPL) Superfund sites are contained within the Tri-State Mining District and consist of the following: Cherokee County, Kansas; Tar Creek, Oklahoma; and Jasper County, Missouri.

A fourth Missouri site is currently in the early stage of an EPA removal program assessment (Newton County, Missouri). EPA Regions VI (Tar Creek, Oklahoma site) and VII (Kansas and Missouri sites) have coordinated on the cleanup actions completed to date. The three NPL sites are complex large area lead sites that have been subdivided into several subsites and/or operable units. The earlier referenced ROD figures (Figures #1-3) depict the locations and descriptions of the Baxter Springs and Treece subsites and the engineering components of the selected remedy. Additionally, the ROD tables (Tables #2-4) include descriptions and comparisons of the selected remedy, including costs, and other evaluated alternatives. Attachment #3 of the ROD contains a description of all 18 original alternatives. This attachment (#4 - Technical Impracticability) is intended to serve as a supplement to the OU-3/4 ROD.

The current OU-3/4 ROD is consistent with prior Cherokee County RODs for operable units #05 (OU-5) and #07 (OU-7) which were issued in 1989 and 1996, respectively. The OU-7 ROD addresses impacted residential areas of the Galena subsite and forms the consistent basis for any residential actions in the OU-3/4 ROD. The OU-5 ROD addressed surface mining wastes and impacted surface water bodies and also waived surface water quality ARARs.

Conceptual Model

The Cherokee County site is underlain by two distinct hydrogeologic units that are not in hydraulic communication. The upper hydrogeologic unit is comprised of Mississippian age carbonates which host the ore bearing mineral deposits that were actively mined. The lower hydrogeologic unit consists of Ordovician age sandy dolomites and lenticular sandstones which are hydraulically separated from the uppermost unit by lower Mississippian age shales and argillaceous limestones. The conceptual hydrogeologic model is depicted by Figure #1 of this attachment.

The uppermost aquifer is in communication with the following features: ore deposits; milling and mining wastes that have been placed in abandoned mine workings; exploration shafts, tunnels, and mine ventilation holes; and mined drift areas. The primary stratigraphic unit which was mined is the Missippian age Boone limestone which is subdivided into at least five formations. The uppermost hydrogeologic unit is unconfined and is characterized by poor water quality due to high levels of calcium sulfate. Shallow aquifer water typically exceeds secondary safe drinking water standards for iron, manganese, and sulfate. The uppermost aquifer is typically low yielding unless solutioned, fractured, jointed, or mined zones (secondary permeability) are encountered, and in these locations, yields are high but the water quality is poor. Extensive mining of the cherty carbonate Mississippian units (Osagian, Meramiecian and possibly Cheresterian age) has produced secondary permeability that is karst-like in nature. Conduit flow occurs in mined and worked areas in addition to typical fracture flow and karst solutioned flow. A regional structural feature (the Miami Trough) consists of a series of northeast to southwest trending karst collapse features. The shallow aquifer flows west to northwest with a hydraulic gradient of 33 feet per mile. Figure #2 of this attachment depicts the stratigraphic section and aquifer properties of the shallow aquifer.

The lower hydrogeologic unit consists of lower Ordovician age sandy dolomite and provides the primary local and regional source of water for most uses such as public water supply systems, industrial uses, and agricultural purposes. The primary formation comprising the lower aquifer is the Ordovician Roubidoux formation. The potentiometric surface of the deep aquifer is approximately 200 to 250 feet deep (approximately 700 feet mean sea level) with a regional flow to the west-southwest and a hydraulic gradient of 25 feet per mile. A relatively thin shale and argillaceous limestone aquitard (10 feet thick) separates the upper unconfined and lower unconfined/semi-confined aquifers in the general Cherokee County area. The lower Missippian age Kinderhookian series units consisting of the Northview and Compton formations make up the regional confining unit. The maximum thickness of these units approaches 75 feet in some locations. Figure #3 of this attachment depicts the stratigraphic section and aquifer properties of the deep aquifer. The confining unit is depicted on earlier referenced Figure #2.

Selected Remedy

The selected remedy provides the same degree of residential or human health actions in both subsites addressed by the OU-3/4

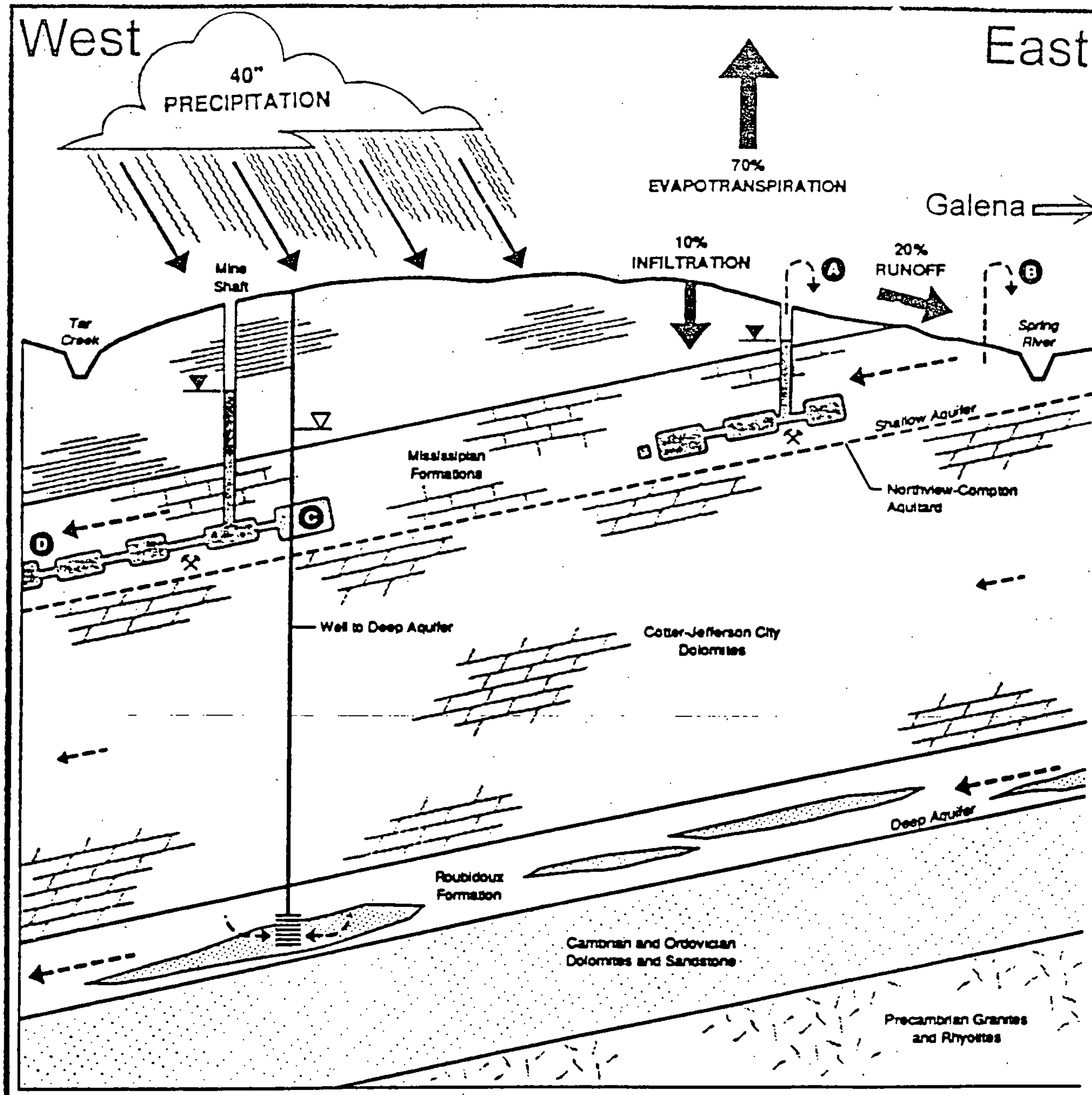
ROD. The primary difference in subsite actions, as stated in the ROD, are the engineering actions for mine wastes in the Baxter Springs and Treece subsites. Engineering actions to address certain types of mine wastes are planned for the Baxter Springs subsite but not for the Treece subsite due to technical impracticability. There are several facts which are pertinent to the TI decision at the Treece subsite. These facts have been thoroughly discussed in various portions of the ROD and are provided in a summary format in the following paragraph. Again, Tar Creek drains the Treece subsite while Spring Branch, Willow Creek, and the Spring River drain the Baxter Springs subsite.

The aforementioned facts include the following: none of the Feasibility Study report or addendum alternatives were deemed capable of meeting chemical-specific ARARs established by the SDWA and the CWA at either subsite; residents in both subsites are currently served by public water supply systems drawing from the deep aquifer and these systems meet maximum contaminant level standards; the shallow impacted aquifer is not used as a primary water source; chemical-specific ARARs were waived at a prior Cherokee County operable unit (OU-5) action; EPA Region VI actions at the Tar Creek site have determined that Tar Creek is irreparably damaged by historic mining activities; Tar Creek is designated as a no beneficial use water body in Oklahoma and no further actions are planned, a recent Region VI 5-year review again confirmed this position; the majority of Tar Creek impacts occur within the Oklahoma portion of the creek flow; any Kansas actions to improve Tar Creek would be short-lived since the creek only flows a relatively minor distance in Kansas before crossing the Kansas/Oklahoma state line and no actions are planned for the Oklahoma portion; any actions, regardless of the extent, would not achieve SDWA standards in the shallow aquifer or CWA standards in surface water; the state of Kansas does not favor engineering actions for Tar Creek; and additional total costs (1994 estimate) of a Tar Creek action were estimated at $65.5 million ($93.2 million for both subsites in 1994 total costs). The reader is referred to sections 9.2 and 11.0 of the ROD for additional TI discussions.

Inordinate Cost Determination

The estimated total costs (1997 dollars) for the selected alternative (3b) is estimated at $7.1 million while the most costly alternative was estimated at $93.2 million (total costs, 1994). The Treece component of the most costly alternative was estimated at $65.5 million in total costs (1994 dollars). EPA considers the increased cost of engineering actions at the Treece subsite to be "inordinantely costly" when considering the limited environmental gain of such an action. Any gain is very limited since the flow in Kansas is minor compared to the entire drainage basin and no actions are planned for the downgradient stream system; thus, if the stream were improved it would immediately become re-contaminated after crossing the Kansas/Oklahoma state line. Additionally, any engineering actions for Tar Creek would be inconsistent with the EPA Region VI approach at the contiguous Tar Creek site, and would also not conform with recommendations from the state of Kansas. Finally, no actions would achieve SDWA standards in the shallow aquifer or CWA standards in surface water, regardless of the extent of the action.

After consideration of all facts, in combination with the size (28 square miles) and volume (4.3 million cubic yards) of mining wastes, EPA considers remediation of Tar Creek at the Treece subsite of the Cherokee County, Kansas Superfund site to be technically impracticable based on inordinate costs from an engineering perspective.



LEGEND

- A - BRUGER MINE SHAFT OVERFLOW - SEASONAL DISCHARGE
- B - LIMESTONE SEEPAGE
- C - LEAKS CAN DEVELOP IN WELL CASING THROUGH SHALLOW AQUIFER
- D - INTERCONNECTED MINE WORKINGS CONDUCT WATER TO OPENINGS ON TAR CREEK IN OKLAHOMA

- ▼ - POTENTIOMETRIC SURFACE OF SHALLOW AQUIFER
- ▽ - POTENTIOMETRIC SURFACE OF DEEP AQUIFER

NOTE: FORMATION BOUNDARIES ARE APPROXIMATE AND DIP IS EXAGGERATED.

Cherokee County, Kansas Superfund Site	Conceptual Hydrogeologic Cross-Sectional Model Downgradient of Galena
FIGURE 1 - ATTACHMENT #4	

Stratigraphic Section and Shallow Aquifer Properties.

System	Log	"Formation"	Lithology	Thickness Range (ft)	Aquifer Properties	
PENNSYLVANIAN		Krebs Subgroup of Cherokee Group	Shales, sandstones, siltstones, coal; localized limestone. Typically absent in Galena; present in Baxter Springs area.	0-450	Small yields (<10 gpm) - domestic and stock uses	
MISSISSIPPIAN		Undifferentiated Chesterian Rocks	Shaley limestone and calcareous shale; some oolitic limestone and sandy shale.	0-120	Yields no water to wells	
		Warsaw Limestone	Cherty crinoidal limestone; glauconite rich bed at base (J-bed). **Commercial Pb-Zn ore.**	0-180	SHALLOW AQUIFER	Yields little water to wells completed in thick bedded, low effective porosity units. Adequate to good yields are supplied from karst features such as solution channels, and from brecciated zones, joints and fractures.
		Undifferentiated Burlington/Keokuk	Cherty, crinoidal limestone. **Commercial Pb-Zn ore.**	20-240		
		Fern Glen Limestone	Dolomitic limestone at base, grading upward to cherty limestone. **Commercial Pb-Zn ore.**	120-200		
		Northview Shale	Calcareous grayish-green shale	0-55	AQUITARD	Yields no water to wells.
		Compton Limestone	Greenish-gray shaley limestone	0-25		Yields no water to wells.
DEVONIAN		Chattanooga Shale	Fissile, black shale; rarely present in mineralized areas.	0-10		Yields no water to wells.

FIGURE 2 - ATTACHMENT #4

Stratigraphic Section and Deep Aquifer Properties.

System	Log	"Formation"	Lithology	Thickness Range (ft)	Aquifer Properties	
ORDOVICIAN		Undiff. Cotter and Jefferson City Dolomites	Cherty dolomite and sandstones with intercalated brownish-green shales.	170-550	REGIONAL AQUIFER	Yields small volumes of water to wells.
		Roubidoux Formation	Sandy, cherty dolomite and lenticular sandstone.	120-200		Good yields obtained from water wells.
		Gasconade Dolomite	Light-gray coarsely crystalline dolomite; sandy dolomite at base.	165-320		Adequate to good yields obtained from water wells.
CAMBRIAN		Eminence Dolomite	Medium bedded to massive, light-gray, coarsely crystalline dolomite; slightly cherty and glauconitic.	140-230		Yields small to good supplies of water.
		Bonneterre Dolomite	Fine-to-medium crystalline, dark gray-brown dolomite	140-230		Yields small to good supplies of water.
		Reagan Sandstone	Medium-to-coarse grained sandstone, grading upward to glauconitic shale and dolomite	0-135		No groundwater information.
PRECAMBRIAN		Rhyolites and Andesites				Rocks do not yield water to wells

FIGURE 3 - ATTACHMENT #4

ATTACHMENT 5 - FINANCIAL FUND INFORMATION

Appendix C to the Feasibility Study

Addendum to Evaluate the Types and Potential Effectiveness of Institutional Controls at the Baxter-Springs and Treece Subsites

Prepared for

United States Environmental Protection Agency
Region VII
Kansas City, Kansas

on behalf of

Cherokee County Superfund Site
Potentially Responsible Parties

by

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May 13, 1993

I. Introduction

The Feasibility Study for the Baxter Springs and Treece subsites discusses in several of the remedial alternatives the use of "institutional controls," i.e. non-engineering access restrictions, at the subsites to restrict the likelihood of human exposure to hazardous substances and thereby reduce potential future risks to human health at the subsites. Like any remedial alternative, the evaluation and potential selection of institutional controls, whether as the sole remedial alternative or in tandem with engineering and treatment technologies, must be undertaken in accordance with the provisions of the National Contingency Plan (NCP), 40 CFR Part 300, which require a thorough analysis of any remedial alternative in accordance with nine decisionmaking factors. Use of these nine criteria allow for an objective comparison of remedial alternatives as to their overall effectiveness in meeting the statutory requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

Since CERCLA was enacted in 1980, the use of institutional controls at CERCLA sites as a means of protecting human health has undergone considerable study by EPA and interested parties, and such controls have been used successfully at a growing number of sites. CERCLA Section 121 indicates a preference for remedial actions that rely upon the treatment of hazardous substances to meet applicable and relevant or appropriate requirements (ARARs) on a permanent basis. However, experience with the CERCLA program indicates that the treatment of high volume, low toxic materials, such as many mining wastes, may not be cost-effective when viewed in light of the risk the materials may pose to human health and the likelihood that persons will be exposed to the materials. In addition, the preparation of a risk assessment, as part of the remedial investigation and feasibility study (RI/FS) process, provides site-specific information that is very useful in tailoring institutional controls, as part of the remedy selection process, to achieve a meaningful reduction of the specific site risks to human health. This can make the entire process more efficient and less costly.

Institutional controls also offer a potential means for preventing future human exposure scenarios that may be unlikely, but nonetheless must be considered by the Agency to meet its statutory responsibilities. CERCLA, unlike other environmental programs, does not contain the type of time limitations, such as in the Resource Conservation and Recovery Act's (RCRA) hazardous waste management program, which employs a 30 year post-closure exposure scenario. Therefore, under CERCLA, materials that may remain at a site are assumed to pose a risk to human health many years into the future, even if certain remedial measures, such as containment, are chosen, since there is a mathematical likelihood that even these precautions can be undone by natural and human intervention. Institutional controls offer a means of controlling such potential exposures. [1/]

This addendum discusses the legal authority available to utilize institutional controls under

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[1/] As is discussed later, the NCP requires a review of a remedial action every five years if hazardous substances remain at the site. This offers EPA flexibility in using institutional controls, because the Agency will be continuing to monitor the site.

the NCP, the types of institutional controls that may be effective in addressing potential risks to human health at the Baxter-Springs and Treece subsites using the nine selection criteria in the NCP, and the means for using one or more institutional controls to protect human health at the subsites in a reliable and efficient manner. Institutional controls appear to offer EPA with constructive approaches for reducing the risks to human health at the subsites and should be given careful consideration in the remedy selection process.

II. Institutional Controls Under the National Contingency Plan

Institutional controls are generally considered to be non-engineering measures which restrict exposure or access to hazardous substances or pollutants and contaminants left at a CERCLA site. They can be as varied as physical barriers, such as fencing, warning signs, or surveillance systems manned by security personnel, or enforceable legal limitations, such as deed restrictions, contracts, zoning provisions, or ordinances that proscribe certain conduct with regard to the use of land.

Although the NCP clearly indicates a selection preference for remedial actions which involve treatment to achieve a permanent cleanup of a site, the NCP also discusses instances in which institutional controls have a key role to play at sites:

> EPA agrees that institutional controls should not substitute for more active response measures that actually reduce, minimize, or eliminate contamination unless such measures are not practicable, as determined by the remedy selection criteria .... EPA believes, however, that institutional controls have a valid role under CERCLA (e.g. section 121(d)(2)(B)(ii) appears to contemplate such controls). Institutional controls are a necessary supplement when some waste is left in place, as it is in most response actions. Also, in some circumstances where the balancing of trade-offs among alternatives during the selection of remedy process indicates no practicable way to actively remediate a site, institutional controls such as deed restrictions or well-drilling prohibitions are the only means available to provide protection of public health.

55 Fed. Reg. 8706, cols. 2-3 (March 8, 1990)(emphasis added).

Where institutional controls are the sole remedy at a site, special precautions must be taken to ensure that the controls will be reliable. Id. This would include assurances from state and local governments that the controls are legally enforceable both during and after the completion of operation and maintenance activities. Other factual demonstrations may be required by the Agency to show the permanence and reliability of specific institutional controls.

The NCP preamble indicates that the decision to use institutional controls is not based upon a single set of factors: "EPA believes that the discussion of an expectation concerning institutional controls in the rule is the appropriate level of detail for guidance in the NCP." Id. at 8707, col 1. Instead, the decision is characterized by flexibility and weighing of site-specific factors.

Mining sites are one of the largest subsets of the sites on the National Priorities List at which institutional controls have played a significant role. Congress and EPA have noted both in RCRA and CERCLA that mining wastes, as a category, may differ from other types of industrial materials in the: (1) hazards they pose to human health and the environment, (2) quantity and location, and (3) availability of cost-effective treatment methods. In light of these factors, institutional controls have been remedial candidates for use either to complement other remedial actions, such as removal and/or containment, or to restrict access to certain areas at which mining wastes are located. The selection of institutional controls has been demonstrated to be appropriate because risks can be shown to be reduced and implementation of the controls is cost-effective and reliable at the sites.

In a paper prepared for the Hazardous Waste Management Division, EPA Region VIII, the use of institutional controls at over twenty different mining sites is critically discussed as to the strengths and weaknesses of institutional controls. [2] Another excellent discussion of the use of institutional controls at mining and other sites is contained in the Feasibility Study for the Whitewood Creek, South Dakota, Superfund Site and Appendix D (and attachments) to the FS, December 8, 1989. A number of institutional controls are discussed in this submission, including deed restrictions, both private and public (see Tab 7, Consent Decree in U.S v Seymour Recycling), and state and local ordinances designed to limit the drilling or use of potentially contaminated groundwater.

In summary, the NCP allows the use of institutional controls at CERCLA sites, provided the requirements of reliability and enforceability can be met. The types of institutional controls and the specific manner in which any controls are screened and selected are broadly and flexibly addressed in the NCP. Finally, institutional controls are currently being used at a number of CERCLA sites, particularly mining sites. Accordingly, it is appropriate to consider the use of institutional controls at the Baxter-Springs and Treece subsites.

III. Use of the Nine NCP Selection Criteria

In conducting a detailed analysis of any remedial alternative, the NCP requires that each

[2] See Sikkema, E., "The Utilization of Institutional Controls at Superfund Sites in Region VIII of the United States Environmental Protection Agency," report prepared for Hazardous Waste Management Division, U.S. EPA Region VIII, Denver, September 24, 1991.

alternative be evaluated with respect to nine criteria:

- (1) Overall protection of human health and the environment;
- (2) Compliance with ARARs;
- (3) Use of treatment to achieve a reduction in the toxicity, mobility, or volume of contaminants;
- (4) Long-term effectiveness and permanence in protecting human health and the environment;
- (5) Short-term effectiveness in protecting human health and the environment;
- (6) Implementability;
- (7) Cost;
- (8) State acceptance;
- (9) Community acceptance.

The first two of these nine are unconditional requirements (unless an ARAR is waived), while the other seven are balancing criteria.

In applying the selection criteria to institutional controls, though, certain considerations are evident. First, institutional controls, by their very nature, do not usually involve treatment of wastes, although certain institutional controls may require a landowner or land developer to take particular actions to ensure that unacceptable exposure to hazardous substances are avoided. This could involve treatment, but may also allow for other alternatives, e.g., containment. Second, by focusing on exposure, rather than the intrinsic toxicity of contaminants, institutional controls may not always result in meeting numerical standards that are embodied in potential human-health ARARs, such as the maximum contaminant levels (MCLs) and MCL goals (MCLGs) under the Safe Drinking Water Act, the Water Quality Criteria of the Clean Water Act, or other similar numerical standards. However, institutional controls may act like action-specific ARARs, whereby the controls will result in levels of protection that would achieve the same degree (or even greater) of risk reduction than that which would be achieved using a numerical ARAR.

It is difficult for purposes of the RI/FS process, which merely identifies potentially relevant ARARs, to specify whether a particular institutional control would meet ARARs at a site. Accordingly, discussion of this criteria during the evaluation of various institutional controls, will be general and provide potential options which would be open to the agency in selecting a remedial action and preparing a Record of Decision (ROD).

IV. Institutional Control Alternatives for the Baxter-Springs and Treece Subsites

As discussed above, institutional controls can fall into a variety of categories and constitute many types of access or use limitations. For purposes of this addendum, two broad groupings of institutional controls are noted: (1) proprietary or privately enforceable controls, and (2) governmental controls, whose adoption and enforcement principally resides in a public body.

Institutional controls at the Baxter-Springs and Treece subsites have been identified in the Feasibility Study as useful in dealing with potential risks to human health from exposures to mine waste materials containing heavy metals. Although certain institutional controls may have applicability to potential environmental risks, at these subsites there are no institutional controls that would substantially or effectively address the potential environmental risks. [3]/ Therefore, this addendum will focus on institutional controls as they relate to human health risks.

The RI/FS for the subsites has identified two potentially significant risks to human health arising from exposure to mine wastes and contaminated groundwater. The first is the possibility that persons could locate residences on mine wastes and children at these residences could come into extended contact with heavy metals, principally lead compounds. EPA models suggest that contact with such mining wastes, principally through ingestion, could result in predicted blood lead levels in these children exceeding the 10 ug/dL lead standard adopted by the Centers for Disease Control (CDC). Current indications are that there are two residences that may be located on mine waste material, although it is not known whether there are any children at these locations and whether the materials have been remediated such that heavy metal exposures are controlled. For purposes of this addendum, it is assumed that these two residences will be actively remediated to eliminate any current risks to human health. Therefore, the only risks to human health associated with mine waste contamination are of a "potential" nature, based upon "future use" concerns.

The second potential human health risk at the subsites is associated with the possible consumption of groundwater from the shallow aquifer. Sampling of the shallow aquifer indicates that in certain locations, the concentration of heavy metals exceed national drinking water standards (MCLs). Whether this contamination is due to former mining activity or is from the natural mineralization of the resident limestones, or both, the restoration of this aquifer is highly impractical from both a technical and a cost perspective. Residents in the subsites have not historically relied upon the shallow aquifer as a source of water, but instead have supported the development of local water districts which tap the deeper aquifer to provide an ample supply of quality water. Nonetheless, there are no existing legal limitations on the use of the shallow aquifer, and even though the water is not currently being used, there is a chance in the future that a homeowner or resident in the subsites could use the shallow aquifer as a source of drinking water and thereby, be exposed to a risk of health effects.

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[3]/ It is possible that certain types of institutional controls may address environmental risks. For example, land use controls to prevent run-off into surface waters may limit harmful exposures to aquatic life at some sites. Fencing or other physical barriers could limit trespass by some animals, but many other animals could easily overcome such barriers by air, water, tunneling or sheer physical force. Nonetheless, use of institutional controls to restrict potentially harmful environmental exposures should not be ignored, but instead evaluated on a site-specific basis.

Accordingly, this addendum evaluates various types of institutional controls that could be employed to limit or manage locating new residences on unremediated mine waste materials and the use of the shallow aquifer as a source of drinking water by residents in the subsites and discusses the potential effectiveness of each control in light of the nine EPA selection criteria and other site-specific information.

A. Consideration of Local Rather State Institutional Controls

In identifying the potential candidate institutional controls, this addendum relies almost exclusively on controls that are localized to Cherokee County and the Baxter-Springs and Treece areas. In focusing the addendum on these types of controls, it should be noted that there was an evaluation of the utility of using Kansas state law in controlling residential development in areas of mine waste and use of the shallow aquifer. Unfortunately, a review of state law indicated there were no existing legal authorities that would be applicable to prevent a landowner from locating a residence on mine waste materials or using the contaminated shallow aquifer as a source of drinking water. Accordingly, either the Kansas legislature or the Department of Environmental Regulation would have to take action to adopt new provisions to control this type of land use.

For example, Kansas' Solid and Hazardous Waste Act, K.S.A. Section 65-3401 et seq. does not address residential and commercial development on contaminated land, except to the extent that the area was an active waste management facility. Indeed, the permits issued under this authority are generally for permission to operate a solid or hazardous waste management or disposal area.

K.A.R. Section 28-29-20 imposes a requirement that before a permit may be issued or renewed for a solid waste disposal area, when wastes will remain at the disposal area after closure, the secretary may require the execution and filing with the county registrar of deeds, a restrictive covenant to run with the land that specifies acceptable land uses and requires maintenance of any waste containment systems. These are to be permanent restrictions unless extinguished by agreement between the secretary and the land owner. However, these restrictions are not expected to be applicable to most of the mined materials remaining in Cherokee County.

The State of Kansas also has the Ground Water Exploration and Protection Act, K.S.A. Section 82a-1201 et seq. which provides for the exploration and protection of groundwater through licensing and regulation of water well contractors and to protect groundwater resources from waste and potential pollution by requiring plugging and other requirements. Although the Act has some relationship to the concerns in Cherokee County of the use of the shallow aquifer for drinking water purposes, the Act does not necessarily apply to a person constructing a well on his own land for domestic purposes.

Although there are other provisions of state law and regulation that potentially address the types of future risk factors identified at the two subsites, none of these provisions appeared to provide current legal authority. The laws and regulations could be amended or new laws and regulations adopted, but it does not appear to be likely that the problems of one County would result in a significant change in state law, especially when there are local approaches that may be available and could be focused on the specific risk-related concerns. Accordingly, this addendum deals primarily with the use of institutional control on a local level rather than a statewide basis.

B. Evaluation of Specific Institutional Control Alternatives

Alternative 1 -- Agreements Affecting Real Property Interests

a. Description

Real property interests in land include deed restrictions, easements, land development rights and ownership, and a variety of covenants or land restrictions. All of these provisions attempt to limit certain types of land uses in a manner that continue into the future or "run with the land." In this regard, the limitation continues to remain in effect even if the property is transferred to other owners.

Land use restrictions could entail agreements which would be negotiated among PRPs and current landowners to affect the title of any parcels of land at which mine wastes are found or which are underlain by potentially contaminated groundwater in the shallow aquifer. Restrictions could be imposed upon the land by the purchase of certain property rights, including fee simple title to the property or development rights, to control the right to construct dwellings or to undertake commercial development without remediation of the mine waste or connection to a public water system.

b. Discussion

For years, the mineral rights associated with property in Cherokee County have been sold to private interests. The sale of certain property rights or the entry of restrictions on the title of real property is, therefore, not novel. There do not appear to be any legal impediments under Kansas law for the sale of such rights to private parties.

However, obtaining the consent of all land owners may be difficult and expensive, unless there is some State or local power to compel cooperation. Cherokee County and the State of Kansas have condemnation (eminent domain) authority, but it is not clear whether it could or needs to be used to require private acceptance of such property limitations. Moreover, without governmental support, the existence of a "captive marketplace" would tend to bid up prices for even less than ownership rights. At a minimum, each parcel would tend to value imposition of a price limitation at the same cost as costs of site remediation and connection to a public water system. Any economies of scale realized in a broader remedial action would be lost.

c. Relationship to the Selection Criteria

(1) Overall protection of human health and the environment;

Assuming land use limitations are met, location of new residences on unremediated mine waste and use of shallow aquifer as a drinking water source would be precluded. Human health would be protected.

(2) **Compliance with ARARs;**

Health risks would be brought within acceptable EPA ranges by precluding residential use of areas contaminated by mine waste or underlain by the contaminated shallow aquifer. Alternatively, a party could remove chat and/or cover chat to remove health risk, connect to a public water system or alternate uncontaminated water supply, and therefore, be able to build residence at the property.

(3) **Use of treatment to achieve a reduction in the toxicity, mobility, or volume of contaminants;**

Treatment of any variety is unlikely. Instead, removal or containment of wastes may occur at some locations. Shallow aquifer groundwater would also not be treated.

(4) **Long-term effectiveness and permanence in protecting human health and the environment;**

Restrictions would continue to appear on the property title unless removed by court order. A key question is whether over a period of time that the restrictions would be ignored by banks, real estate brokers, or new purchasers and therefore, would not be enforced. This is not very likely, though, and the failure to heed such limitations would be enforceable in a court by private citizens, the County or the State.

(5) **Short-term effectiveness in protecting human health and the environment;**

Land use restrictions should be effective in the short-term, since new residences are not currently being constructed in areas where mine waste is located. Affected parcels of land can easily be identified and the development of a deed restriction should not be complex.

(6) **Implementability;**

If implemented by private agreements, the principal problem would be reaching an agreement with all land owners in the affected areas. Experience with access agreements suggests there will be recalcitrant property owners. Determining a fair market value may also be difficult.

To ensure uniform compliance, Cherokee County may have to pass some kind of legislation mandating the inclusion of these provisions on deeds. This could raise the issue of a "takings" if no compensation is provided to land owners. [4] The county may also want to obtain an opinion from the Kansas Attorney General to ensure it has the requisite legal authority to impose such requirements and to identify appropriate legal procedures for enactment of the provisions. [5]

Enforcing these restrictions generally requires resort to the judicial system, thereby raising their costs and creating delays. The restrictions do continue apply even if land is transferred to new parties, but any cloud on the title to land can be a practical problem for a land owner. For example, refinancing of the property, even if it were for non-residential development, may be complicated by the existence of a covenant, deed restriction, or land use right revision. This could work a hardship in an area that is largely comprised of small farms, which may have to borrow against the value of the land to finance yearly operations.

In addition, if lands are remediated and a landowner could show both that soils met acceptable metals' standards and there was access to potable water, the landowner may still have to go to court to remove, e.g. a deed restriction or to have a covenant deemed satisfied. This would add to the cost and the inconvenience of the transaction and tend to less public acceptance of such a remedy.

(7) Cost;

For a majority of parcels, the cost should not be too great given the current low price of land in Cherokee County and the lack of significant property development. Recalcitrant land

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[4] See Lucas v. South Carolina Coastal Council, ___ U.S. ____, 112 S. Ct. 2886, 120 L. Ed. 2d 798, 34 ERC 1897 (1992). In Lucas the owner of the property was called upon to sacrifice all economically beneficial use of his property in the "name of the common good" without compensation. In this instance, the property would be encumbered only as to certain residential uses and even these encumbrances could be eliminated upon undertaking certain actions.

[5] Specifically, the County may want guidance regarding whether such a deed restriction or requirement constituted in some manner or other a condemnation of land or more likely, would be a legitimate exercise of the County's home rule authority to adopt requirements to protect the public health. See Kan. Const. Art. 12 Section 5 and K.S.A. Section 12-101a. The County may also want to determine whether such an action would be subject to the requirements of Kansas' comprehensive zoning program. See K.S.A. Section 12-741 et seq.

owners will be a problem and could raise costs. Costs would be much lower if County were in some fashion to intervene and establish a fair, uniform price.

(8) State acceptance;

There seems to be no reason for state to oppose the approach, except to the degree that County could be deemed to have exceeded its legal authority in adopting such restrictions.

(9) Community acceptance.

Given the substantial economic reliance on the land for agriculture and other purposes, land use restrictions may meet with some opposition. Even if revisions of rights were fairly compensated for, recalcitrant owners would be expected to refuse to cooperate; this has been the experience in trying to obtain site access. If the opposition was sufficiently great, support from the County would be unlikely. The wording of any restrictions to discuss mine wastes rather than "hazardous substances," may help limit certain concerns with using the land as collateral for non-residential loans.

d. Outlook

Land use restrictions are implementable and could be effective in the short- and long-run in limiting harmful exposures to soil and groundwater. They may even result in achieving numerical ARARs (and even treatment) if the landowner decides to remediate the property so as to seek cancellation of the land use restriction. However, land use limitations can have practical problems in their enforcement, present negative effects on non-residential land uses, and be difficult to annul even if no longer applicable.

Alternative 2 -- Governmental Land Use Regulations

a. Description

Land use regulations such as zoning, developmental permit systems, subdivision regulations or other broad governmental requirements are generally countywide or citywide restrictions that limit land use. Zoning is the most common form of such restrictions and is commonly used throughout the United States. Such requirements, though, must be adopted by action of a governmental body, whether by ordinance or statute, and therefore, can be subject to change or amendment.

b. Discussion

Zoning, although very effective and implementable, has several shortcomings when viewed in the context of Cherokee County. First, the County has no existing program for the zoning of properties and the determination of acceptable activities. Any program would be new. Second, although the zoning of particular types of land can be selective, zoning programs are the most legally defensible when they are applicable countywide. Accordingly, a program to zone merely the areas impacted by mining activities, but not other parts of the county could raise legal concerns. Third, zoning generally entails some countywide planning. Although, this may have some benefits in Cherokee County, development of "master" zoning or developmental plans would take time and could prove difficult even if their objectives were very limited. See Alternative Number 4, infra. Finally, under Kansas law, any governing body which has enacted a zoning ordinance or resolution is required to create a board of zoning appeals, consisting of not less than three and no more than seven members. K.S.A Section 12-759(a).

c. Relationship to the Selection Criteria

(1) Overall protection of human health and the environment;

Assuming zoning limitations are enforced, location of new residences on unremediated mine waste and use of shallow aquifer as a drinking water source would be precluded. Human health would be protected.

(2) Compliance with ARARs;

Health risks would be within acceptable EPA ranges by precluding residential use of contaminated areas. Alternatively, a party could remove chat and/or cover chat and connect to a public water system to avoid health risks and, therefore, meet the zoning restrictions and be allowed to build and occupy a residence at the property.

(3) Use of treatment to achieve a reduction in the toxicity, mobility, or volume of contaminants;

Treatment is unlikely for either mine waste or groundwater. Instead, removal or containment of mine wastes may occur at some locations. Future residents would most likely connect to a public water system.

(4) Long-term effectiveness and permanence in protecting human health and the environment;

A zoning program, like any governmental requirement, can be changed by the enacting body. Zoning restrictions on residential development in Cherokee County could be repealed, but, if other environmental programs are any indication, it is more likely that the zoning requirements would form the basis for additional requirements, whether or not environmentally motivated.

A concern in the long-term would be whether by a variance or an appeal to the Zoning Board, certain landowners would be allowed to circumvent the requirements and build residences on unremediated mine waste. This, though, does not appear likely unless the land owner has been able to bring forward credible information that the health risks of concern do not exist at the site.

(5) Short-term effectiveness in protecting human health and the environment;

Development of a zoning program may be slow to implement in the short-term, because the County has no existing program. A more modest program that only addresses the mine waste concerns would be the quickest to implement, although uniformity is a legal concern that must be addressed. Once in effect, a zoning program should be effective and would have the benefit of governmental oversight of residential development.

(6) Implementability;

The County would be advised to seek outside assistance, including the State and local governmental organizations in Kansas in developing and adopting a zoning program. Effective January 1, 1992, the Kansas legislature adopted comprehensive zoning program requirements that apply in both counties and cities. [6] The scope and meaning of the provisions of this new authority is still under development by the State. [7] However, it is clear that Cherokee County has broad authority to adopt an array of zoning requirements. See K.S.A. Sections 12-753 & 12-755.

Developing the requisite plans, surveys, ordinance language, will entail a cost and take some time. In addition, a Board of Zoning Appeals must be constituted, although it is possible that the County Commission could act as the Appeals Board, since it has at least three members.

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[6] See K.S.A. Section 12-741 et seq. Subsection (a) states:

> This act is enabling legislation for the enactment of planning and zoning laws and regulations for the protection of the public health, safety, and welfare, and is not intended to prevent the enactment or enforcement of additional laws and regulations on the same subject which are not in conflict with the provisions of this act.

[7] For example a recent Attorney General opinion responded to a recent request for assistance: "As county counselor for Shawnee County, Kansas you advised us that since the enactment of K.S.A. 12-741 et seq ... confusion has arise concerning the filing of certain plats with the register of deeds." See Kan. Att. Gen. Op. No. 93-39 (Mar. 22, 1993).

Assuming that the County does not try to adopt a comprehensive zoning program, which would simply require more planning and could raise more concerns among the citizens, a more focused program dealing with mining waste areas should be able to be developed and implemented. Some care would be required to ensure that the requirements are not a "taking" requiring the payment of funds or discriminatory because the requirements do not apply from a practical matter throughout the County. Working with the State, particularly the Attorney General's office, such problems may be minimized.

(7) Cost;

Developing a zoning program and its implementation should not be overly expensive in Cherokee County. The County would have to identify and fund some person(s) who would assist in filling out permits to build and would be available to undertake enforcement of the program, including site inspections. This is not seen as a full-time position. If residential development began to grow significantly, user fees may also be a means of ensuring the program remains solvent.

(8) State acceptance;

The State does not oppose the adoption of zoning provisions by the local Counties, indeed, the "home rule" provisions of state law specifically allow such actions. Presumably, the State would be a resource in ensuring that zoning provisions would not conflict with state zoning requirements.

(9) Community acceptance.

The term "zoning" has certain negative connotations to some in the County and could trigger opposition even if it was relatively narrowly focused. In part, this is the reason why no zoning program currently exists. However, since residential development is not active in the County, no one is being immediately precluded from undertaking a planned action. Support for a zoning program may be gaining if justified on human health protective reasons and that the impact on land development is largely positive.

d. Outlook

Zoning, developmental controls, and other broad governmental land use requirements often are most effective when a pre-existing zoning program exists that serves as a framework. At a minimum, an existing zoning program has one or more persons already knowledgeable and responsible for its management; moreover, in Kansas, this would include a functioning board for zoning appeals. In a county, like Cherokee, that has no existing zoning program, development of zoning program to achieve mine waste property control faces practical implementation issues as well as uncertain community support.

Alternative 3 – Dedication of Land for Public Use

a. Description

Deeding over of private lands or real estate interests to public agencies or governmental bodies for the purpose of serving a public benefit including but not limited to park land, lakes, open space, public recreation or sporting, or other publicly determined uses. Future use of the land is controlled by the public entity which can limit uses of the land that could be associated with public risks.

b. Discussion

Since the principal risk associated with the mine waste areas involves residential exposure to mine wastes or groundwater, the dedication of contaminated lands to a public use that would preclude uncontrolled residential development would protect human health and the environment. As the site risk assessment indicates, short-term exposures to the materials, such as trespasser exposures, do not create unreasonable risks to human health.

However, the large amount of disturbed land and the fact that contaminated areas may be miles apart may not make this option particularly attractive for most of the two subsites in Cherokee County. This approach appears to be most desirable when a single, geographically contiguous site is involved. The option may also be advantageous in areas where public parks or recreational facilities are very limited, e.g. in more urbanized areas.

c. Relationship to the Selection Criteria

(1) Overall protection of human health and the environment;

Dedicated land would be precluded from residential development and therefore, the types of exposures that result in health risks would exist. Other uses of the dedicated land should not create new risks other than those identified in the site risk assessment.

(2) Compliance with ARARs;

Certain standards that were ARARs when disturbed lands were in the private sector may no longer apply to lands that are dedicated for public uses. It would be expected that if, for example, that dedicated lands were used as parks that mine wastes may be removed or contained, although the intensity of such actions may be driven by environmental rather than human health concerns.

(3) Use of treatment to achieve a reduction in the toxicity, mobility, or volume of contaminants;

Treatment is not expected to play a significant role in this alternative.

(4) Long-term effectiveness and permanence in protecting human health and the environment;

Certain covenants can be inserted in grants of land to cities and counties, which when they are not unconstitutional (e.g. discriminatory), have been upheld by the courts. If the County were to sell the land, it could at that time limit residential development of certain parcels or require the purchaser to ensure that risks to human health are eliminated. There does not appear to be any reason to believe that the County would ignore its responsibilities, especially since this is now county land.

(5) Short-term effectiveness in protecting human health and the environment;

Getting title to the many parcels of affected land may be difficult and expensive. This would take a great deal of time and would be difficult without County intervention.

(6) Implementability;

It is possible to buy all of the areas in which mine wastes or contaminated groundwater are located, but as discussed above, this could be very difficult. While a person may accept a land use restriction, he may be unwilling to part with ownership of his land.

In certain areas of the county, it may make sense to buy tracts of land for dedication to the County, especially if there are strong indications that there are recreational uses or aesthetic values to the land that the public would enjoy. However, it is not clear that the County even wants the responsibility for the numerous acres of disturbed land in Cherokee County, even if the land is free.

(7) Cost;

This is likely to be an expensive alternative, unless it is used very selectively. The costs would be even greater if considerable land development is anticipated to create recreational or other public use areas.

(8) State acceptance;

It is possible that certain lands could be dedicated to the State rather than the County, which might enhance State support. There appears to be no reason why the State would oppose land dedication to the County, unless administering the lands would create too great of a financial burden.

(9) Community acceptance.

Public acceptance could be a problem if large amounts of land were withdrawn from the private domain, especially if the land is potentially useful for agricultural purposes. Like any option involving land purchase, costs could rise significantly if large amounts of land would have to be obtained. Finally, any lands dedicated to the public would have to be maintained, there would be a management cost, even if activities were limited to ensuring that trespassers were not improperly using the land for residential purposes, e.g. illegally parking a mobile home on the lands.

d. Outlook

Although dedication of land to a public body would significantly limit the use of the lands for residential purposes, the sheer acreage involved raises practical problems. It is not clear that any public body is interested in undertaking stewardship of these lands and the value to the public is limited by the current availability of private lands for recreational and sporting purposes.

Alternative 4 – Environmental Master Planning

a. Description

Creation of a planning commission, likely comprised of representations from Cherokee County, Baxter-Springs, Treece, Galena, and other interested cities to develop a master plan for dealing with the short- and long-term development of land and groundwater affected by mine wastes, including appropriate limitations on land use. Funding may be available pursuant to recently enacted State statutes. [8]/

Any Joint Commission would have to adopt by-laws to govern its operation and conduct public hearings in adopting any recommendations. Recommendations could include a multi-faceted approach to dealing with mine waste lands, including zoning and subdivision requirements, park and recreational development, and other provisions to ensure future use of land protects human health.

b. Discussion

Use of a master planning approach to deal with environmental contamination takes a broader look at the problem and relies, first, upon study and the development of recommendations, rather than assuming that particular controls, such as zoning are needed.

However, in Cherokee County where current risks to human health do not appear to be

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[8]/ See K.S.A. Section 75-5657, which provides for grants to local entities for the development of environmental protection plans. These shall include but not be limited to a sanitary code, subdivision water plan, public water supply plan, solid waste management plan and nonpoint source pollution control plan.

imminent (other than potentially two residences), time may not necessarily be as critical than at other sites. Broader planning may have certain benefits, for example in dealing with certain unique site-specific issues. For example, much of the chat has an economic value and can be beneficially used in asphalt and other construction materials. Developing a countywide plan for dealing with the use of this valuable chat, including encouraging sound management of the materials, may be very beneficial in minimizing future risks to human health.

c. Relationship to the Selection Criteria

(1) Overall protection of human health and the environment;

Planning would result in requirements that would preclude residential development and exposures to materials that created unacceptable risks to human health.

(2) Compliance with ARARs;

Certain action-specific ARARs may be achieved and even numerical limitations, but meeting ARARs is not the principal focus of master planning.

(3) Use of treatment to achieve a reduction in the toxicity, mobility, or volume of contaminants;

Treatment is not a likely result of this alternative.

(4) Long-term effectiveness and permanence in protecting human health and the environment;

If adequate resources are devoted to the planning effort, this option could be very effective into the future. The principal problem in Cherokee County is that significant commercial or residential development has not occurred; instead, the area remains heavily dependent upon agriculture. Accordingly, a "master plan" that addresses residential development may simply be too speculative at this time and therefore, ineffective and subject to future revision.

(5) Short-term effectiveness in protecting human health and the environment;

Since longer-range planning is involved, short-term effectiveness would be minimal, especially when compared to the other more focused alternatives.

(6) Implementability;

Under Kansas' new zoning authorities, counties have the authority to create planning commissions, including joint county-city groups, and to appoint members who serve without compensation. See K.S.A. Section 12-744. The Commission is also authorized to adopt comprehensive land use plans, subject to review and approval of the County and participating cities. K.S.A. Section 12-747. Accordingly, there is no lack of legal authority to implement master planning.

However master planning is intended to result in comprehensive land use controls, including zoning, and therefore raises some of the same implementation problem as zoning (Alternative No. 2), i.e., identifying both planning board members and zoning appeals board, finding ways to finance the preparation of studies or reports on specific problems, and potential public opposition. However, master planning greatest impediment to implementation is likely to be costs, and therefore, outside funding whether from the state or other source may be important in implementing this alternative.

(7) Cost;

Depending upon the level of sophistication, for master planning studies to be useful, generally they must address a broad range of issues and therefore, can be costly. The utility of these studies in Cherokee County, which is not currently undergoing significant land use development may be very limited at this time. Therefore, the cost-effectiveness of this alternative may be low.

(8) State acceptance;

Generally State agencies support a methodical, longer-range approach to environmental issues based upon sound studies. The State, though, may be concerned that such solutions are too far in the future and the value of such studies in solving the site problems is minimal.

(9) Community acceptance.

County residents appear to want action and not more studies of these sites. A master planning effort, without more focused components is not likely to be supported.

d. Outlook

Master environmental planning does not appear to focus as quickly on the future risk issues related to exposure to mine wastes and use of the shallow groundwater as would other alternatives. Although planning is probably a sound approach in theory, in reality, this area is likely to remain primarily agricultural for the next decade and therefore, any planning effort would have to very focused on mine waste issues to be of much practical use. Like zoning, master planning may be premature for the county at this point.

Alternative 5 -- Environmental Construction Code

a. Description

Specific requirements adopted by the county to govern the building of residences in areas in which mine materials are located and there is potential access to the shallow aquifer. Residential development within certain designated areas of prior mining activity in the County would be prohibited until the filing of an application for an environmental occupancy permit. A permit would issue when an authorized county representative determines that building standards based upon prevention of unsafe exposures to mine materials or contaminated groundwater have been satisfied and risks have been reduced to acceptable levels.

b. Discussion

Adoption of an Environmental Construction Code would be pursuant to Cherokee County's inherent police powers to protect citizens from unreasonable risks to health and safety rather than state zoning authorities. [9] In this regard, the code may have more flexibility in not having to be uniformly applied to areas of the county in which mining activities have not taken place.

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[9] Adoption of an environmental construction code would appear to be authorized under the County's "home rule" authority. See Kan. Const. Art. 12 Section 5 and K.S.A. Section 12-101a. Home rule authority exists for a County: (1) where the legislature is silent on a subject and the legislation is not prohibited by constitutional or statutory home rule provisions, (2) to exercise police power to regulate the health, safety, and welfare of the public, and (3) where state legislation is available, but is not uniformly applicable to all cities and counties. See Blevins v. Hiebert, 247 Kan. 1, 795 P.2d 325 (Kan. Sup. Ct. 1990). In adopting such an ordinance, the County would be using its home rule "police power" to protect human health by limiting access to mine wastes and contaminated groundwater.

One issue, though, that may need to be investigated with the Attorney General is whether the existence of Kansas' new zoning authorities would preclude the use of home rule to adopt such a restriction; rather, the County would have to act in accordance with the zoning authority. K.S.A. Section 12-741(a) of the zoning authority indicates that it "is not intended to prevent the enactment or enforcement of additional laws and regulations on the same subject that are not in conflict with the provisions of this act." Such restrictions as the environmental construction code do not appear to be in conflict with the zoning requirements, although it may be prudent to ensure that any public participation requirements associated with the zoning authority be compiled with in exercising home rule authority to adopt an environmental construction code.

Implementability would be through the County's adoption of an ordinance that would preclude occupying any residence that was located within an area in which mine wastes were found without taking steps to ensure that exposures to mine waste materials were within acceptable levels. Standards for soils and mine waste materials could rely upon numerical standards or performance standards, such as ensuring mine waste materials in future residential areas are removed, graded, covered by soils or other clean cover, or similar requirements. Standards for groundwater protection would include connection to local water systems or the use of an acceptable water supply and a prohibition on using the shallow aquifer as a drinking water source.

Such a program, has been raised with the Cherokee County Commissioners who have expressed interest in the program. A model code provision has been prepared and is attached to this addendum. See Attachment 1.

c. Relationship to the Selection Criteria

(1) Overall protection of human health and the environment;

Residential development would be prohibited unless an environmental occupancy permit was obtained. Permit will not issue if site risks are present, such as location of the residence on mine wastes and lack of acceptable drinking water source.

(2) Compliance with ARARs;

Cover or removal of chat to reduce site risks and installation of acceptable drinking water system would be required to obtain environmental permit. Compliance would focus on meeting action-specific ARARs.

(3) Use of treatment to achieve a reduction in the toxicity, mobility, or volume of contaminants;

Treatment of wastes would be unlikely. Cover and containment would be used to reduce site risks.

(4) Long-term effectiveness and permanence in protecting human health and the environment;

Although the program could be abandoned or changed by the County, its relative simplicity in administration supports its continuation. It may be likely to serve as the basis for other types of building requirements that improve the safety of residences and other buildings. The program does not require a large commitment of sophisticated manpower and therefore, could be implemented and maintained by existing County personnel. Program is sufficiently flexible to allow for the building of individual residences with site-specific remediation. This would appear to enhance its likelihood to remain in effect and to protect human health into the future.

(5) Short-term effectiveness in protecting human health and the environment;

Program would not take considerable planning to implement and would immediately preclude unpermitted residential development. As discussed, could be implemented with existing County staff and would not require significant new resources to be brought on-line.

(6) **Implementability;**

A model ordinance has been developed and reviewed by the County Commission and County Attorney. As discussed above, it may be prudent to ensure hearings and other public participation requirements be followed to ensure that the ordiance is on sound legal grounds. Questions could also be addressed to the Kansas Attorney General's office.

The County Health Officer would be the principal official charged with the program implementation and oversight. Relevant duties are expected to require only part-time efforts. Maps of affected areas have been developed and other permitting materials should be able to be developed quickly.

Cooperation among EPA, Kansas, and the County would be useful in determining what must be done at a site from a remedial perspective to allow occupancy, especially with regard to mine wastes. However, assuming that the residence is not a mobile home, excavation of a foundation and the grading of the home site may be compatible with other approaches for reducing site risks.

(7) **Cost;**

Costs of the program should not be significant. Determination of the need to file an application is based upon an inspection of a map. Applicant for permit then has responsibility to show that any risks have been abated. Visual inspection of a site to ensure risks have been addressed would involve some costs as would administration of the permitting program. Permit fees may off-set many of these costs.

(8) **State acceptance;**

No anticipated state opposition, although certain legal issues associated with the use of the County's police powers may arise and will have to be addressed.

(9) **Community acceptance.**

This program is far less complex and broad than a zoning program. Preliminary indications from the County have been favorable. Program would not interfere with non-residential development of property, including agricultural and beneficial use of mining materials.

d. Outlook

The program focuses specifically on the future risks identified as of concern in the RI/FS and does not appear to require the creation of planning boards or boards of appeals. The County Commission would serve as the arbitrator of any appeals from the denial of an occupancy permit.

In implementing the program, the county would need to define the types of building standards needed; this would likely entail input from EPA and the state. However, site preparation for residential development may typically involve activities which would assist in reducing potential exposure risks, e.g. removal of chat, bringing in top soil for cover, and the planting of a lawn, etc.

Alternative 6 -- Contractual Agreements

a. Description

A contract is a legally enforceable agreement between one or more parties who agree to either perform or refrain from performing certain actions for money or other valuable consideration. Contractual agreements normally apply only to the persons or organizations that execute the agreement, although certain contracts have been deemed to create third party beneficiaries to the agreement. Contracts involving site remediation could be executed with land owners to refrain from certain actions, such as residential development or use of the shallow aquifer at a site. Contracts could also be executed with governmental bodies to agree to keep certain programs in effect, to accept oversight responsibilities, or to undertake other actions.

b. Discussion

Contracts are an extremely flexible means of accomplishing specific objectives. When private parties are involved, such contracts may allow for the recovery of damages or provide the basis for injunctive relief if provisions are breached. Contracts could address the right to perform site development, land purchase options, notifications of intent to sell or develop or any number of duties that may be helpful in ensuring persons are not subjected to conditions of risk.

Governmental bodies generally have the right to make contract for necessary services and for other public purposes. In Kansas, though, the provisions of "home rule" may need to be considered with regard to a county's authority to enter into particular contracts. Contracts that are deemed to not be in the public interest can be rendered void.

c. Relationship to the Selection Criteria

(1) Overall protection of human health and the environment;

Depending upon the nature of the agreement, a contract could preclude locating a residence on mine waste and using the shallow aquifer as a source of drinking water. It could also include other measures to control site risks within acceptable levels.

(2) Compliance with ARARs;

Agreements are more likely to call for compliance with action-specific ARARs rather than numerical ARARs.

(3) Use of treatment to achieve a reduction in the toxicity, mobility, or volume of contaminants;

Treatment is not expected in using the contractual alternative.

(4) Long-term effectiveness and permanence in protecting human health and the environment;

Contracts bind individual parties, and unlike land restrictions, may not be enforceable against new owners. Contracts may have a longer duration when agreed to by a governmental entity that would remain in existence. Although a contract can have predetermined remedies in the event of a breach, generally some entity is needed to enforce the the contract. Contracts can also be renegotiated among the parties and terminated by mutual agreement.

(5) Short-term effectiveness in protecting human health and the environment;

A contract with particular individuals may be a very effective means of eliminating certain risks in an expeditious fashion and at a reasonable cost. However, as a sole institutional control, probably too many individual agreements would have to be negotiated to be considered effective in the short-term. An agreement with the County, provided adequate consideration is involved, could bind the County in the short- and long-term to continue to provide services including program administration and enforcement.

(6) Implementability;

Use of contracts to control certain individuals or the County is feasible and implementable. However, sole reliance on contracts would be difficult in light of the large number of persons that could be involved. Contracts also would not necessarily survive the sale of land, although, the contract could require notice be given that land on which mined waste is located before being sold.

Enforcing a contract requires resorting to court, unless some method of binding arbitration is included. It is often difficult for any individual who is not a party to bring action under a contract, even if it would derive a benefit (third party beneficiary). Liquidated damages or provisions controlling specific performance may be very useful in dealing with disputes over site risks.

(7) Cost;

A valid contract requires valuable consideration, although the scope of the contract duties control the price. Costs could be high if contracts were the only means of limiting site access and many land owners would have to be consulted. However, selective use of contracts, especially with the County, may not be particularly costly and effective.

(8) State acceptance;

State opposition would not be expected.

(9) Community acceptance.

Assuming that the contracts were fair to the affected parties, no great opposition would be expected.

d. Outlook

Although contractual arrangements on a person-by-person basis may be very difficult in many areas of the Cherokee site, contractual arrangements with particular individuals or the county may prove very effective in assuring compliance with certain requirements. Monitoring compliance with the contract can be a problem and if the contracting party is rendering some service, then, problems with the quality and consistence of performance can arise.

Alternative 7 -- Financial Instruments or Arrangements

a. Description

Insurance policies or financial instruments such as bonds, trusts, escrows, or deposits that can serve a variety of uses at a site to encourage, protect, and reward cooperation in reducing exposures to potential risk situations. For example, insurance coverage might be offered to private parties that are concerned that their remediation of certain conditions at a site could expose them to Superfund liability. Another example could be a trust or escrow account administered by a third party trustee which could be tapped to assist in funding governmental programs that administer or enforce permit or zoning programs; it could also assist private parties afford user fees. Pools or funds could also assist certain types of private remediation or provision of alternate water.

b. Discussion

Implementation of such financial mechanisms would not appear to be particularly difficult, although the particular means for providing funds to a local or state government may have to be accompanied by other agreements to ensure that transfer of funds to the government is legally proper. Nonetheless, financial pools that augment or act as backups to local programs can provide substantial incentive to keep a successful exposure control program in effect. Often the financial pool, by virtue of its ability to draw interest can be self-financing into the future or until the obligation is satisfied.

c. Relationship to the Selection Criteria

(1) Overall protection of human health and the environment;

The goal would be to use financial incentives to insure overall protection of public health.

(2) Compliance with ARARs;

Financial mechanisms could be used to encourage meeting action-specific ARARs and to keep in maintenance a program that required ARARs to be met.

(3) Use of treatment to achieve a reduction in the toxicity, mobility, or volume of contaminants;

Treatment is not expected to be the major function of the financial instrument, but rather to ensure site risks are minimized.

(4) Long-term effectiveness and permanence in protecting human health and the environment;

The principal concern is that there is adequate funding to ensure that long-term effectiveness is maintained. The five year EPA review could include an evaluation of the adequacy of any financial instrument or arrangement in achieving the continuation of the program and the protection of public health. Interest would augment any funds invested in a pooling agreement.

(5) Short-term effectiveness in protecting human health and the environment;

A financial instrument or arrangement could be expeditiously put into place and could be tapped to fund agreements with private parties or the County to address any short-term risks. Since there is great flexibility in the types of financial arrangements available, one approach could be implemented in the short-term while mechanisms for dealing with the longer-term needs are determined.

(6) Implementability;

There is a great deal of flexibility in the array of financial instruments or agreements that could be selected to achieve objectives. Managing the disbursement of money in a manner that avoids depletion of the fund, yet ensures desired actions are undertaken is an important consideration. To this end, the selection of an independent trustee to manage the fund in a sound fiscal and impartial fashion could be beneficial, since those who fund the account and those who may benefit have to feel fairly treated. Determining initial payments into a trust or the amount of life insurance or bond coverage will be the most difficult process, although this should be able to be settled with outside assistance. This alternative would appear to be a good solution both in the short-term and long-term, if cost projections are reasonably accurate.

(7) Cost;

If used to fund County administration and enforcement of a permit program, like the environmental occupancy permit program, costs may not be extremely large. If wide-scale remediations are to funded, costs could rise substantially. Good administration of the financial program would avoid transaction cost losses.

A trust account or financial pool, using expected annual program costs and expected rates of return for trust funds would be a practical method of financing over the long-run. Determination of initial deposit would be determined after program elements are determined.

(8) State acceptance;

Assuming that funding is adequate, there should be no significant State opposition.

(9) Community acceptance.

Again, if funding is adequate and the instrument or fund is fairly administered, there should not be community opposition.

d. Outlook

Use of these mechanisms is likely to complement other institutional controls whether public programs or private agreements. EPA's five year review authority could be invoked if coverage or pools prove to be inadequate due to unusual circumstances.

Alternative 8 – Physical Barriers/Surveillance

a. Description

Access barriers to prevent human exposure to mine wastes and contaminated groundwater include fences, warning signs, security systems, surveillance systems, guards, and other types of systems that would limit physical access.

b. Discussion

Perhaps the simplest means of restricting access, especially to areas of immediate or acute risks, these restrictions appear to be most suited to selective, localized use. These controls may be effective on a interim basis while longer-term approaches are being devised.

c. Relationship to Selection Criteria

(1) Overall protection of human health and the environment;

Such barriers would prevent contract with mine wastes, but would not be particularly effective in dealing with groundwater contamination. Local water wells are often difficult to visually identify depending upon the terrain.

(2) Compliance with ARARs;

Compliance with ARARs, other than to limit direct access, would be very limited.

(3) Use of treatment to achieve a reduction in the toxicity, mobility, or volume of contaminants;

No treatment is expected to result from the use of access barriers.

(4) Long-term effectiveness and permanence in protecting human health and the environment;

These types of access barriers may not be particularly effective in the long-run unless they are maintained and regularly monitored. Fencing unless repaired when broken will provide no protection, although trespassing is not considered to be a high risk to human health.

(5) Short-term effectiveness in protecting human health and the environment;

These access barriers used selectively could be very useful at individual areas in the short-term. Again, maintenance and oversight is needed.

(6) Implementability;

Obtaining the authority to place a fence or another structure on private land would probably require the cooperation of the site owner. Wide scale reliance on such barriers is probably infeasible and would become increasingly a problem over the long-term. However, such access barriers if regularly monitored could provide immediate assistance in problem areas, where access by children is expected to be a problem.

(7) Cost;

Cost could be more significant if considerable acreage is involved and personnel must be hired to undertake long-term monitoring. Such barriers may not be considered cost-effective when compared to other approaches which provide longer term benefits.

(8) State acceptance;

There should be no significant State opposition, so long as this is not the only institutional control.

(9) Community acceptance.

Limited access barriers may be acceptable so long as they do not overly limit private use of land that is not likely to be developed for residential use or to be subject to substantial trespass.

Alternative 9 -- Public Education Programs

a. Description

Organized efforts to prepare educational materials for private citizens and governmental officials to explain available methods for reducing risks of exposure to hazardous substances whether located at Superfund sites or associated with other residential and local conditions, and to apprise individuals, especially those who could be of special risk, of health effects testing or other treatment that may be useful in dealing with exposures.

b. Discussion

Avoiding exposures to certain materials is a means of protecting public health, especially if the measures are relatively non-intrusive. For example, the RI indicates that children and pregnant women are most at risk from lead exposure, however, the risk for children may be lowered by good hygiene, such as having children wash their hands before eating if they have been outdoors and exposed to mine waste materials; other measures include avoiding the use of chat or mine tailing in areas where children play, e.g. sand boxes. People also need to be apprised of other sources of exposure to lead such as lead paint in houses, lead drinking water piping, and, to a lessening degree, lead in motor vehicle exhaust and suggestions for lowering risks.

c. Relationship to the Selection Criteria

(1) Overall protection of human health and the environment;

The goal of the program would be to inform people how they can lower their risks to lead and other potentially harmful materials and to assist them in reducing risks.

(2) Compliance with ARARs;

An education program would not necessarily ensure compliance with ARARs, but would explain how to minimize risks of contact with mine wastes and contaminated groundwater.

(3) Use of treatment to achieve a reduction in the toxicity, mobility, or volume of contaminants;

No treatment would be achieved.

(4) Long-term effectiveness and permanence in protecting human health and the environment;

If continued into the future and made part of the County's educational curriculum, health programs, and governmental information releases, the program would continue to educate persons about the risks of exposure to heavy metals. As more persons are aware of risk, there is a continued dissemination of information.

(5) Short-term effectiveness in protecting human health and the environment;

This program could be very effective in the short-term, especially with regard to children being exposed to lead. Many simple means are available to reduce lead exposures, including avoiding the use of chat or tailings in sandboxes or in driveways; removing lead paint used at a residence; good hygiene, especially washing children's hands before meals; and allowing tap to run for a few minutes before drawing drinking water in homes with lead piping. Most of these precautions could be immediately undertaken and would be effective in the short-term. Since health effects from certain lead exposure are reversible, short-term action could be very effective from a health perspective.

(6) Implementability;

The educational program would not be complex to implement. Educational materials would have to be produced and County personnel apprised of any special risks and control measures for reducing risks. Outside groups, such a schools, hospitals, and the media would be expected to assist in this effort.

Discussions with the Cherokee Health Officer indicate a willingness to implement such an education program. The basics of such program are contained in Attachment 2 to this addendum.

(7) Cost;

Short-term costs would be moderate and expected to be reasonable in light of the value of heightening public awareness. Long-term costs would be subject to planning and evaluation of how to ensure adequacy of continued educational efforts.

(8) State acceptance;

State support would be expected.

(9) Community acceptance.

Preliminary discussions with County personnel have been favorable. Community acceptance would be expected.

d. Outlook

Since there are certain measures that private citizens could take to lower potential exposures to certain heavy metals such as lead, implementation of a public education program would appear to have significant benefits at very low costs. The key will be the steps that must be taken to institutionalize the program so it can continue to prompt protective behavior into the future.

IV. Summary Comparison of the Institutional Control Alternatives

A. Primary Versus Supplementary Institutional Controls

The preceding evaluation of the various institutional control candidates for use at the Baxter-Springs and Treece subsites indicates that there are potential benefits in the use of each of the various options, however, several of the candidates are not "stand alone," remedial alternatives. For example, the expected effectiveness of alerting citizens to the potential hazards posed to children and pregnant women of exposure to lead and other heavy metals and the steps that can be taken to lessen exposure should not be undervalued merely because this alternative is not a legally enforceable access limitation, like a deed restriction or local land use ordinance.

Basically the institutional control alternatives fall into two broad categories: (1) alternatives that would be a "primary" means of controlling use of an area for residential development and (2) alternatives that would "supplement" primary control options to enhance reliability or permanence. The primary control alternatives would include: Alternatives No. 1 (deed restrictions), No. 2 (governmental land use/zoning), No. 3 (dedicated land use), No. 4 (master planning) and No. 5 (environmental construction code). The "supplementary" institutional controls would be the remaining four alternatives including No. 6 (contracts), No. 7 (financial arrangements), No. 8 (access barriers) and No. 9 (public education).

Based upon the foregoing evaluation, implementation of an effective program of institutional controls would entail the selection of at least one "primary" control alternative. This alternative would be expected to provide the principal means of ensuring protection of human health by controlling future residential development in affected areas. Since almost all of the primary control alternatives discussed above rely either upon the action of a private individual or the government to oversee the alternative's implementation and enforcement, some additional "supplementary" control may be warranted to enhance reliability and permanence of the primary institutional control. Accordingly, it is antcicipated, that the use of institutional controls would be a "package" of primary and supplementary controls. This approach appears to have been used at other sites which have utilized institutional controls.

In addition, if there were "special situations" caused by either unique site-specific conditions, recalcitrant land owners, or other conditions, any one of the above institutional controls may be useful on a "special circumstances" basis. One of the most obvious "special circumstances" controls discussed in the addendum is the use of the public education program, Alternative No. 9, to assist individuals from exposing themselves and their children to avoidable risks.

Using a combination of one or more institutional controls, would strengthen compliance with the nine selection criteria; this is wholly consistent with the goal of the NCP in the selection of a remedy. It also utilizes the flexibility and discretion that EPA has signalled in the NCP as appropriate in the use of institutional controls.

B. Preliminary Observations on the Alternatives

The goal of this addendum was to explore the various types of institutional controls that have been suggested as useful at CERCLA sites and determine, using EPA selection criteria and other information, whether certain of the alternatives should presumptively be screened out as impractical or whether other alternatives are clearly preferred for use at the Baxter-Springs and Treece subsites. Regardless of whether one or more of the alternatives are ultimately selected for use by EPA, many details remain to be resolved before concluding that any of the alternatives actually fulfill the selection objectives.

However, based upon the above analysis, certain factors appear evident. First, in light of the lack of any pre-existing land use program in Cherokee County or private interests that would be pushing for such programs to be developed, any "primary" institutional land use control program to be expeditiously implemented must be relatively simple and well-funded. The County does not have the resources nor are there other parties in the County with resources willing to bring about such land use programs.

Second, a focused program that specfically addresses the potential future risks of residential development of areas affected by mining wastes is likely to be easier to implement and to finance both in the short- and long-term. As a program becomes more complex, it is difficult to predict resource needs.

Third, of the primary institutional control options, Alternative No. 5, the environmental construction code alternative is currently the most developed in terms of its content and its scope. A model ordinance has been prepared and reviewed by the County Commission. Although each of the other control options are implementable and would appear to be potentially reliable each has certain limitations to their implementability. Zoning or other land use ordinances may require planning and appointment of governmental infrastructure, although this is not a substantial burden. Deed restrictions will be difficult to obtain complete participation unless the County, State or EPA intervenes to force uniform cooperation. Dedicated land and master planning may involve more participation than what is currently desired or practical for the County.

Fourth, supplementary controls may be warranted to adequately fund any of the "primary" institutional control programs. Supplemental controls could represent an effective means for meeting the selection criteria requirement of permanence and reliability. Of the available alternatives, No. 7, which specifically discusses the use of one or more of the following -- insurance, trust funds, bonds or other financial agreements -- to support and enhance the development and implementation of a primary institutional control, appears to be the most attractive. A fund that could disburse funds to the County, but also draw interest and be managed by an impartial trustee, appears to be an attractive mechanism for addressing the issue.

Finally, Alternative No. 9, the public education program is a narrowly focused alternative. However, its expected effectiveness suggests that it be carefully considered along with the primary and supplementary control alternatives.

The level of funding for institutional controls will depend on which controls are selected, the anticipated level of residential development in the county, and a number of other important factors. The FS assumed institutional controls would cost around $400,000 to fully implement and maintain. Based on the current lack of development in the County, this could be a significant overestimate.

ATTACHMENT 1

RESOLUTION NO._____

A RESOLUTION ADOPTING AN ENVIRONMENTAL HEALTH PROGRAM FOR THE PROTECTION OF THE PUBLIC HEALTH AND SAFETY FOR THE DEVELOPMENT OF PROPERTY LOCATED IN THE CHEROKEE COUNTY SUPERFUND SITE.

Whereas, mining in the Kansas portion of the Tri-State Mining District occurred from about 1876 to 1970, and

Whereas, this mining activity resulted in the deposition of unprocessed and processed mine wastes on the land surface at several locations in Cherokee County, and

Whereas, the ore deposits mined were located in geologic formations containing water and locally known as the shallow aquifer, and

Whereas, the mineral extraction from these formations modified the hydrogeology and potentially altered the concentration of several metals in the water of the shallow aquifer, and

Whereas, the U. S. Environmental Protection Agency (EPA) designated this area of southeastern Kansas as the Cherokee County Superfund Site in 1983 and initiated investigations, and

Whereas, these investigations identified potential risks to human health from long-term, continued incidental ingestion of mine waste and/or consumption of water from the shallow aquifer in the vicinity of the ore deposits, and

Whereas, the Cherokee County Commission is authorized by the State of Kansas to exercise the use of police powers to protect the health, safety and welfare of the citizens, and

Whereas, the expressed intent of the Cherokee County Commission to protect the health, safety and welfare of the citizens of Cherokee County.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNTY COMMISSION OF CHEROKEE COUNTY, KANSAS:

ARTICLE 1. ENVIRONMENTAL HEALTH PROGRAM FOR THE CHEROKEE COUNTY SUPERFUND SITE

Section 1. Purpose and Intent.

The purpose and intent of the Environmental Health Program is to protect the public health in formerly mined areas of the Cherokee County Superfund Site. The program will limit potentially excessive exposure to metals from surface mine wastes and shallow aquifer water. Building sites for building or structures for human occupancy, proposed to be built on surface mine wastes, will be required to be remediated to prevent ingestion of the mine waste. Buildings for human occupancy will also be required to provide safe and potable water.

The administration and geographic application of the Environmental Health Program is limited to that area of the Cherokee County Superfund Site where there is a potential for excessive human health risk due to exposure to metals. This resolution shall not affect the use of property, density of development, building construction, or subdivision of the land within the Cherokee County Superfund Site.

Section 2. Definitions.

A. Applicant: The property owner, or duly designated agent of the property owner, of land on which the construction activity will occur.

B. Building or structure: A structure including enclosed space surrounded by exterior walls designed, intended or used for occupancy by persons. Included by way of definition are site built homes, mobile homes, and manufactured homes.

C. Cherokee County Superfund Site: An area of approximately 25 square miles in the southeastern corner of Cherokee County, Kansas that has been designated by the US Environmental Protection Agency (EPA) as a superfund site under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA or Superfund). The Cherokee County Superfund Site has been divided into six subsites representing the areas of former lead and zinc mining within the Kansas portion of the Tri-State Mining District. These are the Galena, Baxter Springs, Treece, Badger, Lawton and Waco subsites.

D. Construction Envelope: The limits of construction activity associated with the building or structure, including the site area devoted for front, side and rear yard areas.

E. Cover Material: Uncontaminated soils or other suitable coverings to prevent the ingestion of surface mine waste material.

F. Director of Public Health: The person designated by the County Commission as the Public Health Officer of the County, also refers to his or her designated representative.

G. Ground Water Assessment Area: The area of the Cherokee County Superfund Site where metal concentrations in the shallow aquifer could potentially exceed the State of Kansas' safe drinking water standards in relation to former mining operations.

H. Surface Mine Waste Assessment Area: The area of the Cherokee County Superfund Site containing surface mine waste material. The definition includes areas containing accumulations of surface mine wastes, areas formerly covered with surface mine wastes and now partially reclaimed, and other areas associated with prior mining activities and potentially containing elevated soil metals concentrations.

I. Surface Mine Waste: Processed or unprocessed earthen material deposited on the surface by prior mining activities including development rock, mill tailings, chat and slag.

J. Shallow aquifer: Ground water in the Mississippian Formations which generally occur at depths between the surface to between 150 feet and approximately 1000 feet below the ground surface at the Cherokee County Superfund Site.

K. Temporary water source: The use of bottled water or other means of water imported to the site as approved by the Director of Public Health.

Section 3. Applicability of the Environmental Health Program.

A. Environmental Health Assessment Areas. Central to the administration of the Environmental Health Program is the creation of two environmental health assessment areas, the Surface Mine Waste and Ground Water Assessment Areas. This resolution shall be restricted to property to be improved for human habitation that is totally or partially within either or both of these assessment areas. The Surface Mine Waste Assessment Area shall be established to address the potential health risks associated with the ingestion of mine wastes. The Ground Water Assessment Area shall be established to address the potential health risks associated with the consumption of water from the shallow aquifer. These two assessment areas have been delineated and are shown on Exhibit One and Two.

B. Uniformity in Application. This resolution shall be uniformly applicable to all residential, commercial, and industrial development for purposes of human occupancy or habitation. The use of land for agricultural purposes is exempted from the resolution. This resolution shall be applied to land and structures intended for public or quasi-public use or occupation by the general public.

C. Non-conforming Structures. This resolution shall not apply to structures built before the adoption of this resolution. Structures built before the adoption of this resolution shall be considered legally non-conforming. A non-conforming building or structure may be remodeled or expanded. A non-conforming building or structure may be replaced or restored within nine months of damage or destruction of not more than 50 percent of its appraised valuation by fire, explosion, or act of God. A lawful non-conforming building or structure that is damaged more than 50 percent of its value may not be rebuilt, repaired, or used unless it is made to conform to the regulations of this resolution.

Section 4. Administration and Enforcement.

The County Director of Public Health shall be responsible for the administration and enforcement of the Environmental Health Program. The Director of Public Health is authorized to inspect the construction site or building to ensure compliance with the provisions of this Article.

Section 5. Methods of Site Remediation for Construction in the Surface Mine Waste Assessment Area.

A. Application. The construction of buildings or structures totally or partially within the Surface Mine Waste Assessment Area shall be required to meet the standards and provisions of this Section. Site remediation is limited only to the construction envelope where the building or structure is proposed.

B. Methods of Site Remediaton. Site remediation shall comply with one of the following accepted methods. The intent is to have the surface mine waste material buried, covered, or removed from the construction envelope to prevent human ingestion.

(1). Excavation and removal to on-site or off-site areas.

(2). Covering with topsoil, concrete or other uncontaminated suitable material to prevent ingestion of surface mine waste material.

C. Alternative Site Remediation Methods. The Director of Public Health is authorized to approve alternative methods of site remediation that comply with the intent of ensuring a safe and clean site. The Director of Public Health may request a professional engineer to submit a certified report outlining the alternative method of site remediation. This report shall detail the techniques of site remediation and methods employed to ensure code compliance with this Article.

Section 6. Potable Water Supply Source.

A. Application. All structures for purposes of human occupancy in the Ground Water Assessment Area shall be supplied water from a Rural Water District, municipality, or other reliable source of drinking water that meets the State of Kansas' drinking water standards in order to receive an Environmental Health Certificate. The use of water from the shallow aquifer in the Ground Water Assessment Area shall be limited to agricultural and other non-potable purposes, unless a specific determination is made under Section 6 B.

B. Alternative Water Sources. The Director of Public Health is authorized to approve alternative water sources, provided they insure a safe and permanent source of water. The Director of Public Health may request a licensed laboratory to submit a certified report outlining compliance with the State of Kansas' requirements for safe water. The report shall outline the monitoring, maintenance or testing methods to ensure permanent compliance if needed. The Director of Public Health is authorized to require testing of alternative water sources when deemed necessary. All costs associated with an alternative water source, including periodic testing, shall be the responsibility of the applicant.

Section 7. Procedural Process of the Environmental Health Program.

A. Procedural Overview. The procedural process of the Environmental Health Program involves an initial, two-step procedure. The initial, first-step is for all landowners within the Cherokee County Superfund Site to verify if their property is located within an Environmental Health Assessment Area. The second-step is for the landowner to apply for and obtain an Environmental Health Certificate, if required due to location within an Environmental Health Assessment Area.

B. Assessment Area Verification. Each landowner located within the Cherokee Superfund Site shall be responsible for contacting the Director of Public Health prior to construction to obtain verification as to whether their proposed building or structure is located within one or both of the Environmental Health Assessment Areas. If the building or structure is not located within an assessment area, then the landowner is authorized to commence construction. If the Director of Public Health determines the proposed building or structure is located in an Environmental Health Assessment Area the Environmental Health Certificate is required.

C. Method of Assessment Area Verification. The Director of Public Health shall use the Cherokee County Environmental Health Assessment Map for verification, along with an on-site inspection of the property when warranted.

Section 8: General Procedures for the Issuance of an Environmental Health Certificate

A. Approved Application Required. No person, firm, corporation or governmental agency shall erect, construct, excavate for, or convert any building or structure designed or intended to be inhabited or occupied by humans, or do any work regulated by any portion of this resolution, or cause the same to be done, without first obtaining an approved application for an Environmental Health Certificate for buildings or structures proposed to be located within one of the Environmental Health Assessment Areas.

B. Time frame for Certificate Issuance.

(1). It shall be the duty of any landowner for determining whether a proposed building or structure requires an Environmental Health Certificate and to submit an application in accordance with Section 11 for the Environmental Health Certificate to the Director of Public Health.

(2). The Director of Public Health shall have a maximum of ten working days to review and approve or deny an application for an Environmental Health Certificate. A denial of an application shall be accompanied with a written explanation of the reasons for denial. If an incomplete application is submitted, the Director of Public Health shall ask the applicant to resubmit a complete application. The ten day review period begins with the submission of a complete and accurate application form. The Director of Public Health shall mail the approved or denied certificate application or the applicant can obtain the approved or denied application from the office of the Director of Public Health.

(3). The approval of an application for an Environmental Health Certificate shall expire by limitation and become null and void if the building or work approved is not commenced within 180 days of the date of approval. The Director of Public Health may grant extensions upon just cause.

(4). After inspection of the site and upon determination that applicant has met all requirements of the Sections 8, 9, and 10, the Director of Public Health shall issue to the applicant an Environmental Health Certificate.

(5). The County Commission may establish a fee for application for and issuance of an Environmental Health Certificate. Such fee shall be based upon the administrative and inspection costs associated with the issuance of the Environmental Health Certificate. Any fee shall be established by separate resolution of the County Commission.

C. Certificate Required. No person, firm, corporation or governmental agency shall inhabit or occupy, or allow any person to inhabit or occupy, any building or structure subject to requirements of this resolution that has not been issued and maintains a valid Environmental Health Certificate

Section 9. Specific Procedures for the Ground Water Assessment Area.

A. Documentation. The applicant shall be responsible for providing the Director of Public Health with written documentation from an official agent of a reliable water source that potable water is or will be available to the building or structure. Submission of said documentation, along with the completed certificate application, will initiate the issuance process by the Director of Public Health.

B. Timing of Work. The connection to a reliable water source shall be completed prior to the occupancy of the building or structure.

C. Temporary Water Source. The Director of Public Health is authorized to issue a permit for a temporary water source not to exceed a maximum of one year from the date of occupancy. The temporary permit is intended to be an interim measure while a reliable source of potable water is being obtained or water lines constructed to the building site. A temporary permit shall not be issued unless the Director of Public

Health is presented sufficient evidence to indicate a reliable water source will be provided in the extension period.

Section 10. Specific Procedures for the Surface Mine Waste Assessment Area.

A. Inspection Notification. After approval of an application for an Environmental Health Certificate, the applicant shall notify the Director of Public Health when the site is complete and ready for inspection. The Director of Public Health will either approve or deny the site remediation in accordance with the requirements of Section 5.

B. Timing of Work. The inspection of the surface mine waste remediation shall be completed prior to occupancy of the building or structure.

C. Re-inspection. The following measures shall be applied when the Director of Public Health determines that the site remediation is not in compliance with the standards for site remediation.

(1). The Director of Public Health shall provide written or verbal notice to the applicant that the site remediation work failed to comply with the provisions of this resolution.

(2). The applicant or responsible party shall be given adequate time to correct the deficiencies and perform the work in accordance to the provisions of this resolution.

(3). Upon completion of any additional site remediation, the applicant shall notify the Director of Public Health, who shall conduct a re-inspection of the site and either approve or deny the remediation as meeting the requirements of Section 5.

(4). If the site remediation is denied, an Environmental Health Certificate shall not be issued and the applicant shall have the right to appeal the decision of the Director of Public Health in accordance with Section 14.

Section 11. Application Form of the Environmental Health Program

A. Application. One form shall be used to verify location within an assessment area and to issue the Environmental Health Certificate. The form shall be furnished by the Director of Public Health.

(1). Identify and describe the work to be covered by the Certificate.

(2). Describe the land on which the proposed work is to be done by legal description and/or street address, or by a similar description that will readily identify and definitely locate the proposed building, structure or work.

(3). Verify if the proposed building or structure is located in the Surface Mine Waste Assessment Area.

(4). Verify if the proposed building or structure is located in the Ground Water Assessment Area.

(5). Identify the applicant/owner by name, address, and phone number.

(6). Identify the contractor by name, address, and phone number.

(7). Indicate the use or occupancy for which the proposed work is intended.

(8). Identify the source of authorized water supply, and verify submission of written documentation from the authorized water supplier.

(9). Be signed by the Certificate applicant, or his or her agent.

Section 12. Stop Work Order.

Whenever any building or structure located within the Cherokee Superfund Site is under construction without having first obtained the necessary Assessment Area Verification or an approved application for an Environmental Health Certificate in compliance with the provisions of this resolution, the Director of Public Health may order the persons engaged in doing or causing such construction activity to stop until the necessary verification or application for a certificate is approved. The Director of Public Health shall issue a written notice to the landowner or contractor and inform them of the requirements of this Article. Only after failure to respond to the written notice, shall the Director of Public Health post a "Stop Work Order" at the job site.

Section 13. Occupancy Violation.

Whenever any building or structure is occupied which is not in compliance with the provisions of this resolution, the Director of Public Health may order such use discontinued and the structure vacated until brought into compliance. The Director of Public Health shall serve written notice to the owner or occupants. Such person shall discontinue the occupancy within the prescribed time by the Director of Public Health after receipt of the notice to make the structure comply with the requirements of this resolution. Failure to comply with the order to the Director of Public Health will be addressed in accordance with the violation and enforcement provisions of Section 15.

Section 14. Appeals.

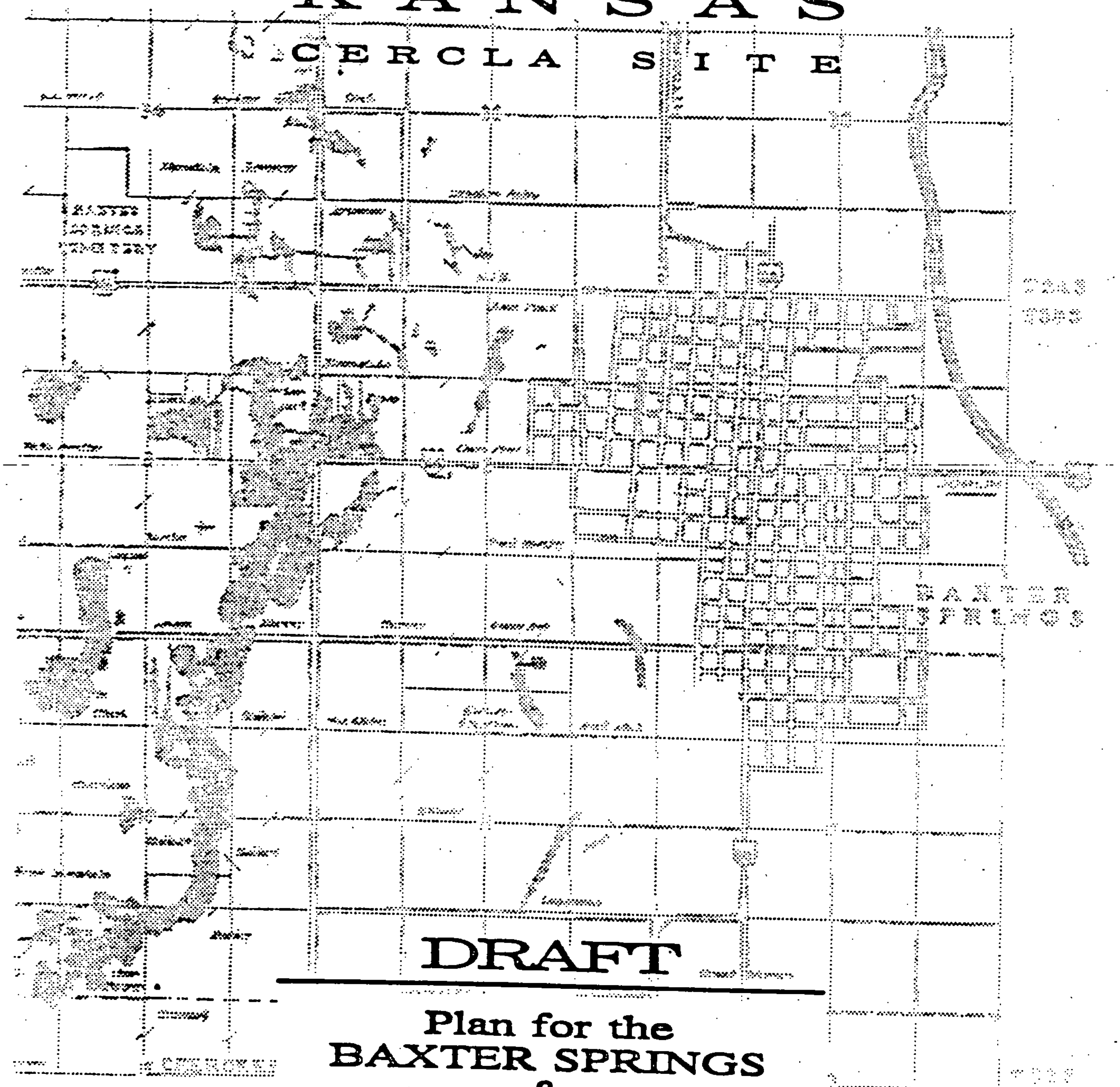
The County Commission is authorized to hear appeals regarding administration and interpretation of this Article. Any interested party seeking an appeal shall file with the County Clerk a letter detailing the reason for the request and subsequent evidence to warrant the justification of an appeal from the provisions this Article. Said letter shall be submitted at least 10 days before the next regularly scheduled meeting of the County Commission. The County Clerk shall schedule the appeal for hearing and review by the County Commission.

Section 15. Violations and Enforcement.

It shall be unlawful for any person to violate any of the provisions of the Article. The provisions of K.S.A. 19-4701 through 19-4738 shall govern the practice and procedures for the enforcement of this Article.

ATTACHMENT 2

CHEROKEE COUNTY KANSAS CERCLA SITE



DRAFT

Plan for the BAXTER SPRINGS & TREECE Public Information Program

DAMES & MOORE

introduction

The historical tri-state mining district of Oklahoma, Missouri, and Kansas was once one of the most productive lead and zinc mining areas in the United States. Mineral deposits were discovered in the area in the early 1800s. The mining, drilling, and milling activities that followed resulted in numerous shafts, waste piles, and mine structures throughout the area. In the 1920s, lead and zinc were discovered near Baxter Springs and Treece, and the area became a thriving business center. Following World War II, demand for lead and zinc decreased, as did mining in general. In 1970, virtually all mining in the tri-state area ceased.

Although the mining industry has declined, reminders of the associated operations still exist. Inactive mining sites, including chat piles, remain in the tri-state mining district. Studies are being conducted to determine the most effective way to resolve environmental problems associated with mine waste materials.

The majority of the community has been involved with the mining industry for generations. Even though there is a long history of association with mining, there may not be an awareness of the health and safety issues related to lead and the steps that can be taken to limit exposure to the various sources.

Lead-based products and by-products are part of our economy and are present in our environment. Lead-based paint and plumbing are in many of the local homes and businesses. Some potential sources of lead exposure are directly related to mining. For instance, since the late 1960s, mill waste piles in the area have been actively quarried for local commercial uses such as aggregate for paving roads and driveways. There are also tailings piles still accessible to the public. All of these potential sources of lead exposure are present in the Baxter Springs/Treece area. Therefore, there are several ways for residents to be exposed to lead.

The Baxter Springs and Treece Subsites Participating Group is sponsoring development of this *Plan for the Baxter Springs & Treece Public Information*

introduction

Program to assist with informing Baxter Springs and Treece residents as to the potential health impacts associated with lead exposure.

This Plan was developed on behalf of the Participating Group by Public Information Specialists with the engineering and environmental consulting firm of Dames & Moore. In preparing this Plan, several of the members of the technical team for the Cherokee County Project, representatives of the Participating Group, and the Baxter Springs Chamber of Commerce were contacted. Discussions focused on demographic information for Baxter Springs and Treece, site characteristics, and existing community information channels.

In this Plan, a strategy for disseminating lead-related information to the Baxter Springs and Treece residents is described in detail, including:

- Objectives
- Target Audience
- Tools & Techniques
- Timeline

objectives

The specific objectives of this Program are:

- To provide information to the residents of Baxter Springs and Treece about lead in general, and about mining and non-mining sources of potential lead exposure.
- To raise the awareness of the Baxter Springs and Treece residents as to the potential health risks associated with exposure to lead in their local environment.
- To provide the Baxter Springs and Treece population with information on preventative measures they can take to limit lead-related exposure.

target audience

To be most effective, this Public Information Program should be directed toward informing community members in the Baxter Springs and Treece area as to the potential risks for the "at-risk" population, and offer suggestions on how to minimize exposure.

While it is important to inform the entire community as to the potential hazards of lead exposure, national health studies show that young children (infants through six years of age) are the most susceptible to the negative effects of lead exposure. Studies also indicate an elevated prenatal risk.

Therefore, the primary target audience for this program includes those who are best able to control the exposure of the "at-risk" population:

- pregnant women
- primary caretakers of pre-school age children (parents, guardians, daycare providers, teachers)

Other members of the community may also be concerned about the potential health risks associated with exposure to lead. Therefore, secondary target audiences for the program include:

- primary caretakers of school-age children
- elementary through high school students
- medical professionals
- leaders of youth organizations (sports, hobbies, clubs)
- local recreationists (motorcyclists, bicyclists, hunters, fishermen)
- any other concerned community members

tools & techniques

The key to success for this program is getting factual information about lead-related health risks out to pregnant women and the primary caretakers of young children. Information dissemination within small rural communities, such as Baxter Springs and Treece, is built more strongly on interpersonal communications than traditional public relations techniques.

The general approach recommended for this program is to establish an effective community network of information sources viewed as trustworthy and reliable by the general public, and provide them with appropriate informational tools. This approach includes the utilization of existing communication channels to the maximum extent possible.

A cooperative effort between the Participating Group, Cherokee County officials, and Kansas State officials is suggested for implementing the Program.

The following tools and techniques are specifically recommended for the Baxter Springs and Treece Public Information Program:

- Information Folder
- Central Information Contact
- Community Information Network
- Public Meeting
- Community Presentations
- Media Relations

INFORMATION FOLDER

An information folder containing lead-related health risk information would be compiled. This folder would include five brief fact sheets on lead-related topics prepared by Dames & Moore and printed in the Baxter Springs/Treece area. Each fact sheet will reinforce the theme of how to

tools & techniques

reduce exposure to lead. Specific fact sheet topics would include:

- Can Exposure To Lead Be Dangerous?
  - lead in the environment
  - use of lead-based products
  - presence of lead by-products
  - results of health risk studies

- How Can I Be Exposed To Lead?
  - exposure pathways
    - naturally-occurring sources
    - lead-based products
    - by-products of lead industry
  - list of facilities to contact for residential soil/water testing

- Who Is At Greatest Risk?
  - unborn infants
  - infants through children age 6

- What Can I Do To Minimize Exposure To Lead?
  - increase awareness
  - take preventative measures

- Should I Or My Child Be Tested?
  - warning signs
  - list of testing locations for blood lead levels

To best address specific community concerns, information in the fact sheets would be presented in question/answer format, using concise, easy-to-understand terms.

Since each piece of information is a separate document, the folders can be easily tailored for specific information requests. Additional lead-related public information materials already developed by various health organizations and agencies would be collected by Dames & Moore Public Involvement Specialists. When appropriate, these materials would be inserted into the folder.

tools & techniques

COMMUNITY INFORMATION NETWORK

To assist the Central Information Contact in responding to lead-related concerns, Dames & Moore recommends establishing a Community Information Network comprised of:

- medical professionals/local medical society (especially obstetricians, gynecologists, pediatricians, and midwives)
- members of civic organizations
- church leaders
- teachers/daycare providers
- other key community contacts

Public Involvement Specialists would conduct phone calls/interviews to determine who is interested in becoming involved with the group, discuss candidates with the Participating Group and involved agencies, and would then determine who would be the most effective members of the network.

Dames & Moore then suggests conducting a group meeting or one-on-one briefings to present a project overview, clarify the roles of the network members, and to discuss available information tools (primarily the Information Folder). Regular group meetings would prove beneficial in assessing community concerns and determining effective response mechanisms.

Following organization of the network, the Central Information Contact would coordinate the efforts of the Community Information Network. Dames & Moore would be available for community relations consultation during the early stages of network development.

PUBLIC MEETING

Dames & Moore would organize and conduct a Public Meeting in a combination Open House and

Panel Session format. The Public Meeting would be held in the Baxter Springs Community Center. Prior to the Public Meeting, a meeting rehearsal would be held to run through the presentations and discuss potential public questions. All available project personnel who are participating in the meeting would be asked to attend.

The Open House would begin three hours prior to the Panel Session, allowing community members a convenient opportunity to informally meet with project personnel on a one-to-one basis and express their concerns related to the Baxter Springs and Treece Subsites and lead-related health issues. This format also gives the project team and panel members the opportunity to establish a positive rapport with members of the community.

Several information tables would be set up in the meeting room. Each table would be an information station for a specific topic, staffed by appropriate personnel. Visual aids and information sheets prepared by Dames & Moore would be available at each table. Copies of the Information Folder would also be distributed.

Following the Open House, a more formal Panel Session would take place. The panel would be comprised of technical/medical project personnel, members of the Participating Group, agency representatives, the Central Information Contact, and members of the Community Information Network. The meeting would be facilitated by a Public Involvement Specialist from Dames & Moore.

The Panel Session, scheduled to last approximately one hour, would begin with brief overview of the Cherokee County Site by technical project personnel. Maps, photographs, and charts would be used as necessary. A presentation of lead-related health issues by a medical expert would follow. Information on lead exposure and preventative measures would be presented with the use of simple charts. Panel members would then respond to questions from the public.

Following the Panel Session, panel members would be available to answer questions on a one-to-one basis.

A sign-in list would be maintained, and meeting attendants would also be offered the opportunity to submit any questions/concerns they may have in writing.

In order to be most successful, the Public Meeting would need to be widely publicized within the Baxter Springs and Treece community starting three weeks prior to the meeting date. Announcements and press releases would be prepared by Dames & Moore for publication in *The Baxter Citizen*. The Central Information Contact and members of the Community Information Network would be asked to announce the Public Forum.

Meeting flyers would be prepared and posted in local shops/businesses, and distributed to elementary school teachers and medical professionals in the area. The flyers could also be mailed to all post office box holders in Baxter Springs and Treece.

COMMUNITY PRESENTATIONS

Being available to respond to group information requests would build credibility for the Public Information Program and help to gain community support. The Community Information Contact would be available to make presentations to local professional and civic organizations upon request. This would also include school curriculum support if requested. Project team personnel would be available assist with these presentations on an as-needed basis.

Presentation materials to explain lead-related health issues, the Cherokee County Site Public Information Program, and any other project-related topics would be prepared by Dames & Moore. If appropriate, visual aids prepared for the Open House/Panel Session would be used. The Information Folder would be distributed at these presentations.

tools & techniques

MEDIA RELATIONS

The Baxter Citizen weekly newspaper, radio station KIXS (in Joplin), and television stations KSN, KOAM, and KODE (in Joplin) are important sources of information within the community. Therefore, establishing a positive rapport with local reporters/editors/producers is essential for efficient dissemination of information about the Baxter Springs and Treece Subsites and the Public Information Program.

A Public Involvement Specialist from Dames & Moore would initiate contact with the appropriate media representatives and inform them of the Public Information Program for the BAxter Springs and Treece Subsites. The Public Involvement Specialist would then prepare a Media Kit (similar to the Information Folder) and send it to the media contacts.

Press releases would be prepared when project milestones are achieved, and sent to the attention of the media contacts. Public meeting announcements would also be sent to the media contacts for publication in the newspaper and announcement on the radio and television.

timeline

The activities discussed in this Public Information Program are to be carried out in conjunction with the implementation of the remedial actions approved by the Environmental Protection Agency in its Record of Decision. The Record of Decision is expected to be released in the summer of 1993.

However, the groundwork for establishing the community network should begin sooner so that potential issues of concern, such as the release of technical data and human health risk information for other nearby sites, can be addressed in a proactive rather than reactive fashion.

The sooner a reliable information network is set up in the community, the sooner credibility for timeline

the Public Information Program can be established.

Once the Central Information Contact and Community Information Network are established, they can continue the information program past the completion of the remedial action activities for the Baxter Springs & Treece Subsites.

notes